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THESIS

ON RISK: RISK AND DECISION MAKING IN MILITARY COMBAT AND TRAINING ENVIRONMENTS

by

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13. ABSTRACT (maximum 200 words)

All decisions involve risk; yet the subject is poorly understood and difficult to define. Understanding risk is vital for military leaders that prepare their forces to operate in risky environments against adversaries that seek to impose risk upon their enemies. Furthermore, the decisions of military leaders affect those subordinates under their command and ultimately the will of the nation that has sent them abroad. It is paramount, therefore, that we utilize a decision process to reveal how emotions can affect our judgment. Frequently, cultural forces in the military can result in ill-informed and emotionally biased decisions that are an irresponsible execution of duty. We address this problem by defining the objective components of risk using mathematical concepts then characterizing the nature of risk in different military environments using those concepts. Our approach uses economic principles, game theory, and decision theory to illustrate how calculations of risk should influence decision-making. Objectively defining risk will aid in revealing the subjective components of risk, where the mathematical principles explain both how decisions are effectively made and how to make decisions effectively. Risk in training and risk in combat pose two very different problems; but to be fully understood both environments must be viewed together. This detailed analysis and research aims to create a more informed decision making process and a more sophisticated decision maker.

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Thanks to our wives and children who were forever caring, understanding, and loving every time we mentioned the word “Thesis.”

Thanks to our advisors who challenged us with complex ideas and then taught us how to explain them in simple ways.

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I. INTRODUCTION

As former infantry company commanders we both previously thought we understood risk. After all, we routinely made assessments of risk as part of our duty in either training or combat. In our discussion of the topic we realized something remarkable, namely that two commanders, with the same job and the same training can produce two very different assessments of risk for the same event. On top of those different assessments there are additional reactions to the assessments that make risk a topic worth studying. First, in our experience the assessments are almost always universally accepted. Second, risk assessments in military training and combat environments usually deal with risking soldiers' lives, or risking accomplishing a very important mission.

Most military leaders understand risk as something to be avoided by filling out a worksheet. The Army uses the Composite Risk Management Worksheet (CRMW) that involves listing hazards that would possibly occur during a training event or a combat mission as well as an assessment of the frequency of each hazard. Because of the occasional "pencil whip" approach to the worksheet that is widely viewed as career-insurance in the event of an accident we both agreed that a rigorous approach to the topic of risk was a journey worth taking.

A. METHODOLOGY

Since the current military approach to risk involves little training or concrete understanding, our methodology is rigorous. We begin in the basic mathematical principles of dispersion, variance, range, and expected value to define risk in its most simple and concrete form. To deepen the definition, we include classic game theory to illustrate risk in an environment where adversaries impose risk on one another. With this baseline understanding we utilize the basic economic principle of supply and demand to illustrate the relationship between training and combat risk, two environments that we find are separate but best calculated together. Finally, decision theory and game theory

together illustrate the inherently complex and risky environment of combat. Our illustration is abstract but is supported by several practical examples of how to assess and measure risk in decision-making.

For us, the topic of risk is not only interesting for our thesis, but is vital to us as leaders in the military. If the status quo is to only make sure a worksheet is properly filled out instead of applying thought to a rigorous decision process, then we become part of a continuous cycle of leadership failures. This work aims to end that cycle.

II. RISK FRAMEWORK

A. RISK WITH ONE DECISION MAKER

The mathematical concept of expected value, the product of value and probability, is the basis for objectively defining risk. Expected value is the value of an event, based on the probability it will occur over many trials. In each calculation there may be a vast difference in outcomes, but when you average *many trials* together they reveal a specific value that one can legitimately guarantee.

A simple way to understand expected value is using the popular game show "Deal or No Deal."[1] In this game a player selects a suitcase from a set of suitcases that contain varying amounts of money. Which suitcase contains which amount of money is unknown. Furthermore, a banker knows the values contained in each suitcase and can offer an alternative amount of money for the player, before the player opens the selected suitcase revealing his prize. For instance, if the player has a choice between two suitcases, knowing that one suitcase contains $100 and the other suitcase contains $0 he can determine the probability of selecting each value is 50% or .5. Using expected value he determines the value of the game is $50. The equation for the expected value of this game is: $E(X) = \$100(.5) + \$0(.5) = \$50$. If the banker offers the player $40 before the player opens his selected suitcase, the player can make $100, $40, or zero dollars depending on his choice.

As the player faces his choice, it is important to understand what he is risking. First, his choice is either to take $40 or to select a suitcase. If he selects a suitcase he could gain the benefit of $100 or gain $0. Therefore, he is risking the guarantee of $40 when he chooses to select a suitcase because of the equal probability of either $100 or $0. This concept illustrates how risk specifically deals with potential cost. In his book *An Anatomy of Risk*, William Rowe defines risk as "the potential for unwanted negative consequences of an event or activity."[2] In this case, the negative consequence of

[1] To play a game of "Deal or No Deal," see http://www.nbc.com/Deal_or_No_Deal/game/flash.shtml.

[2] William Rowe, *An Anatomy of Risk* (New York: John Wiley & Sons, 1977), 24.

selecting the suitcase with zero dollars is gaining no money when the banker extended his hand with $40. Specifically, the risk of selecting a suitcase is $40. The informed player understands that if he decides to select a suitcase he is equally likely to gain $100 or gain $0. Although he is trying to win there should be no surprise, due to the equal probability, if he ends up empty handed. In the same way, when making decisions in risky environments the informed decision maker should be aware of the probabilities of the outcomes, and if the decision rests on a 50/50 shot, the negative consequence should be equally expected as the positive benefit.

Seemingly, the simple choice would be to always select a suitcase, for the expected return is $50, which is more money than the banker is offering. However, it is important to highlight the use of *many trials* compared to a *one-time* decision when using expected value. If the player played this game 100 times, he will average $50 over *many trials*. The player might select the suitcase with $0 two times in a row. On the third game, if he selects the suitcase with $100, he would make an average of $33.3 per game, which is not that bad considering he "lost" twice and "won" only once. If the player is only playing the game *one time* then the only concrete guarantee that he can rely on is the probability or chance assigned to each suitcase. In this game, it is equally probable for him to gain $100 or $0. The only way for him to guarantee a gain in a single trial is to select the $40 that the banker is offering him. The expected value of the game of $50 is greater than the banker's offer of $40 when utilizing decisions with many trials.

Using many trials to formulate an expected value can be graphically depicted as a normal distribution. The expected value over many trials is the average, but each individual trial contributes to a dispersion, or variance, within a normal distribution. It is possible for each individual trial to be above or below the average, potentially creating a value far from what is expected. This possibility reveals Thomas Schelling's conclusion that "appreciable risk" exists where success, even when all decisions are made correctly, may not be achieved.[3] This anticipation is important in order to identify when a decision

[3] Thomas Schelling, *The Strategy of Conflict* (Cambridge, MA: Harvard University Press, 1960), 203.

is of high risk or low risk, so the decision maker understands to anticipate possible outcomes before the results of his decision occur.

B. DECISIONS OF HIGH AND LOW RISK

When one faces a decision intended to create a specific outcome, the variance of possible outcomes over *many trials* determines the degree of risk. A large variance depicts the range of the average deviation from the mean resulting in an array of possible outcomes that may occur close to or farther away from the expected outcome. The large variance depicts the large amount of risk.[4] Expected value is the average of outcomes over many trials. The mean, or average, is another term that depicts expected value. A story of two golfers provides an illustration to understand high and low risk in relation to deviation from the mean. Golfer 1 plays multiple rounds and scores between 84 and 86. Golfer 2 however, shoots between 70 and 100. These two golfers have the same average, or mean, score of 85. Their ranges are drastically different, with Golfer 1 having a range of 2 (86–84) and Golfer 2 a range of 30 (100–70). Although they have the same mean, Golfer 2 is a riskier player. On any given day, Golfer 2 has the potential of shooting under par, but with this potential gain comes the potential cost of shooting in the triple digits.

Another example of this dynamic is the known variance of indirect fire weapons. Comparing two commonly known systems, the 81mm mortar and naval gunfire, shows that when an observer calls for fire on a particular target, one system is more accurate, or less risky, than the other. Greater accuracy determines that the round will likely land within a certain distance of an identified target. The system with lower variance, a 81mm mortar, exemplifies the "less risky" decision. While naval gunfire is a larger caliber round, the accuracy of this system is less than the 81mm mortar so it portrays a "high risk" in missing the target. Figure 1 depicts normal distributions with different variances.

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[4] James G. March, *A Primer on Decision Making: How Decisions Happen* (New York: The Free Press, 1994), 7.

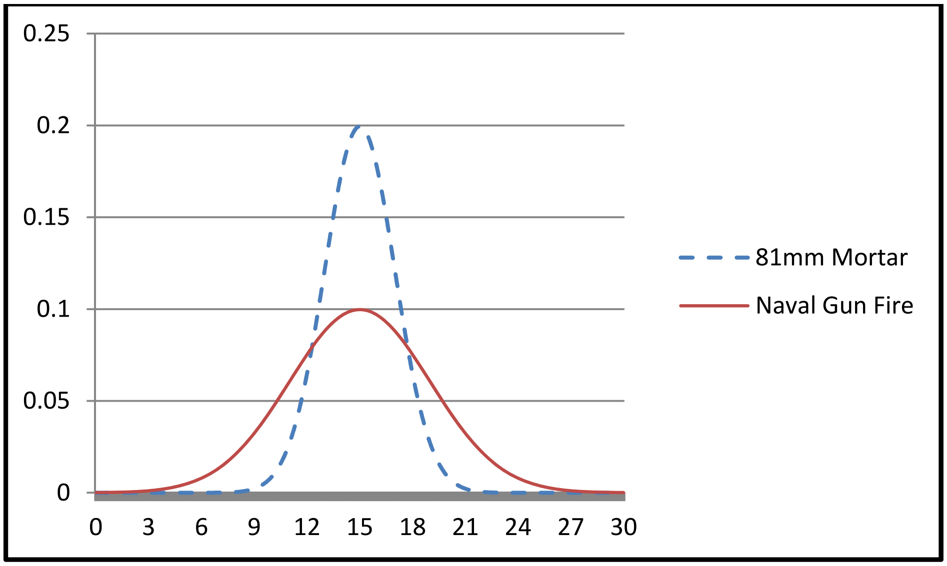

Figure 1. Normal Distribution of Two Indirect Fire Systems with Different Variances[5]

The “flatter” solid curve in Figure 1 depicts a decision with high variance. The “taller” dashed curve depicts a decision with low variance. Application of the idea of variance to a decision reveals that different situations or different decision makers can determine whether a decision is of high risk or low risk. Furthermore, while many believe that the results of a decision are often the best indicator of whether the decision was ‘good’ or ‘bad’, it is possible to have a good decision with a bad result and also a bad decision with a good result.[6] Uncertainty can account for an unintended result. The example of different indirect fire systems can help us understand how uncertainty is related to decisions concerning risk.

[5] This graph is meant to simply depict the differences in accuracy of the two weapons systems and does not reflect specific number values.

[6] March, *A Primer on Decision Making*, 6.

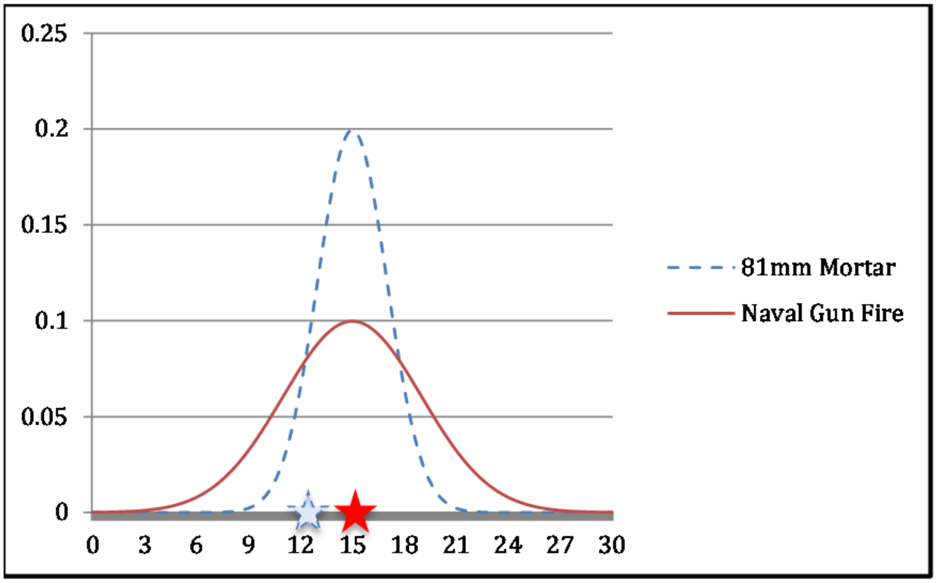

Figure 2. Depiction of More Accurate System with Less Accurate Result in One-Trial

Figure 2 depicts two rounds of indirect fire that impacted near the intended target. Unexpectedly, the naval gunfire round landed closer to the target than the 81 mm round. The risky decision, depicted by naval gunfire, ended up with a better result than the less risky decision, depicted by the 81 mm mortar. While both rounds landed in the area that they would be reasonably expected to land, over many trials one would not expect the naval gunfire to be more accurate than the 81 mm mortar. Leaders must not narrowly assume the results are the primary indicator of a good decision.

Adding knowledge to a decision lowers the variance, or risk, and creates a more informed and accurate decision.[7] This principle is best illustrated by the concept of conditional probability.[8] A story of a street magician and four friends reveals how knowledge can change the odds, or probability, in favor of the decision maker. A magician walks up to four friends on the street and asks if they can guess what card out of a standard 52-card deck he just flipped over. The first guy was taken off guard and has no indication of what the card is, but only knows that his odds in guessing it are 1/52. The

[7] Rushworth M. Kidder, *How Good People Make Tough Choices: Resolving the Dilemmas of Ethical Living* (New York: Harper, 2003), 112.

[8] Donald P. Gaver and Gerald L. Thompson, *Programming and Probability Models in Operations Research* (Blemont, CA: Wadsworth Publishing Company, 1973), 290.

second friend happened to catch a glimpse of the card as it was flipped and saw that it was black making his odds of guessing correctly 1/26. The third friend was paying a bit closer attention and saw that the card was in fact a spade, and he is tempted to guess knowing that his odds are 1/13. The last friend had bent down to tie his shoe and could see the corner of the card underneath as the magician pulled it from the deck, determining that it was an ace of unknown suit and color, giving him the best odds of 1/4. This story shows how independently each friend achieved a different level of information. Independently, they all had varying degrees of probability in guessing the correct card. Even more interesting is that if they pooled all their information together, and talked about what they saw, they know with absolute certainty that the magician pulled the Ace of Spades from the deck. Adding knowledge to any decision will increase the probability of making the right call.

Making the right call is as much about properly using the information available as it is about the timing of the decision. There is risk in executing with incomplete information, but there is also risk in attaining more information. Determining whether the risk of gaining more information adds enough cost to outweigh the cost of executing the mission without the information is a common challenge. The Army FM 6–0 *Mission Command* states, “The art of command includes deciding when to make decisions versus waiting for more information.”[9] This statement in military doctrine poses difficult problems for commanders and requires further analysis.

Going deeper into the relationship between time and information reveals the close ties these variables have with risk decisions. First, it is possible to make the right call too late or too early, where a good decision at the wrong time becomes the wrong decision. Second, information decreases risk yet there is a point where waiting, possibly for more information, actually increases risk.[10] The dynamic between information, time, and risk is paradoxical because delaying a decision to gain more information with the intent of making a better decision can increase risk where “attempting to lower risks actually

[9] U.S. Army, *Field Manual 6–0 Mission Command: Command and Control of Army Forces* (Washington, DC: Army Publishing Directorate, August 2003), 2–17.

[10] Bruce R. Kingma, *The Economics of Information: A Guide to Economic and Cost-Benefit Analysis for Information Professionals Second Edition* (Englewood, CO: Libraries Unlimited, Inc., 2001), 89.

raises them or, alternatively, displaces them on to other objects."[11] Third, an increase in risk is the result of the delay of decision not the result of too much information. More information increases knowledge that reduces risk when used properly. These problems are best avoided by understanding that the optimal time to decide is when the marginal cost of information equals the marginal return for that information.[12] While it is impossible to know the optimal point of the amount of information concerning the timing of a decision, knowing the dynamics of time and information will aid leaders in weighing risk in the process of decision-making.

The process of decision-making when objectively weighing risks is understood using expected value and dispersion. These mathematical principles address natural risks that are universally present in an environment. The concept of game theory will illustrate risk with two competing decision makers, as with two commanders in armed conflict.

C. RISK WITH TWO COMPETING DECISION MAKERS

Game theory provides an abstract method to study how two competing decision-makers impose risk on each other and how each player tries to maximize their own outcome. In each game, the decisions of each player involve some degree of risk.

The classic game of Chicken, where two opposing players choose whether to stay the dangerous collision course or veer aside, provides an example of how risk is imposed by competing adversaries, essentially an attack or not attack situation. The possible outcomes of each player's decision yield varying degrees of preferred results for each player.

1. The Game

The set-up of the game identifies how the options for each player interact with the other and how each action can impose risk on the opposing player. Figure 3 illustrates, with the use of letters, how each strategy combines to produce a result.

[11] Aaron Wildavsky, "No Risk is the Highest Risk of All," in *Readings in Risk*, eds. Theodore S. Glickman and Michael Gough, 120–128 (Washington, D.C.: Resources for the Future, 1990), 122.

[12] Kingma, *The Economics of* Information, 147–148.

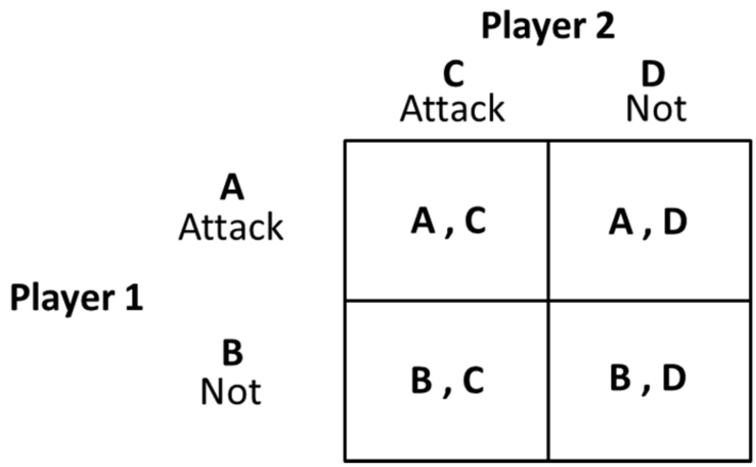

Figure 3. Player 1 vs. Player 2 in the Game of Chicken

There are four possible results:

AC – Player 1 Attacks; Player 2 Attacks

AD – Player 1 Attacks; Player 2 Does Not Attack

BC – Player 1 Does Not Attack; Player 2 Attacks

BD – Player 1 Does Not Attack; Player 2 Does Not Attack

Understanding how the "game" is played is important in order to move to the next step of ranking the options available to Player 1 and Player 2. An assumption in this "game" is that both players are attempting to maximize their individual payoff. For the purpose of this "game", the rank order for Player 1 and Player 2 are in Tables 1 and 2. Ranking the options is necessary in order to illustrate the desired outcome of each player. The classic game of Chicken is a partial conflict game in which each player has the same options, but both players rank their options opposite of one another.

Player 1 Options:

4 – Best – Player 1 decides to attack and Player 2 does not attack

3 – Next Best – Player 1 and Player 2 both decide not to attack

2 – Least Best – Player 1 decides to not attack and Player 2 attacks

1 – Worst – Player 1 and Player 2 both decide to attack

Table 1. Options Available to the Player 1 Ranked from Best to Worst (4 to 1).

Player 2 options:

4 – Best – Player 2 decides to attack and Player 1 does not attack

3 – Next Best – Player 2 and Player 1 both decide not to attack

2 – Least Best – Player 2 does not attack and Player 1 does attack

1 – Worst – Player 2 and Player 1 both decide to attack

Table 2. Options Available to Player 2 Ranked from Best to Worst (4 to 1).

Based on the rankings of the options listed above in Tables 1 and 2, the “game” and the Nash Equilibrium are illustrated in Figure 4.

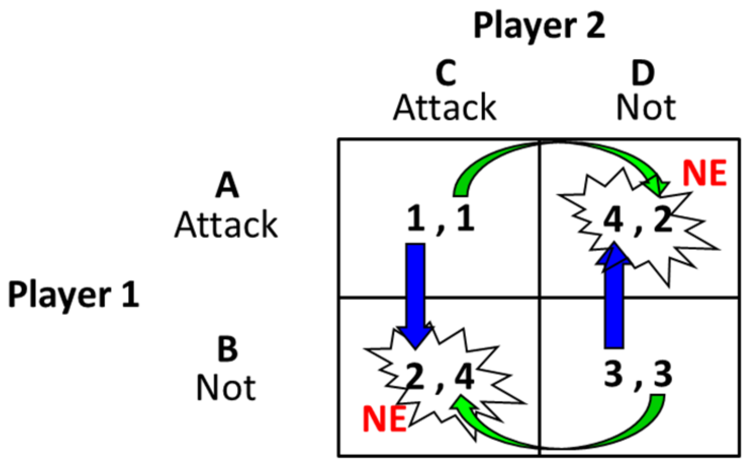

Figure 4. Player 1 vs. Player 2

Figure 4 illustrates the most likely outcome without Player 1 and Player 2 communicating with one another. The arrows, (Player 1 – Blue and Player 2 – Green), indicate the direction each side would shift based on their opponent's move/policy. Neither player has a dominant strategy, meaning both will change their positions based on the decision of the other. The Nash Equilibrium is a point at which no player can benefit by departing unilaterally (by itself) from its strategy associated with an outcome.[13] As a result of the expected payoffs, it is determined that a Nash Equilibrium exists at both (2 , 4)—Player 1 does not attack and Player 2 attacks, as well as (4 , 2)—Player 1 attacks and Player 2 does not attack. This point is where each player is stable because he cannot improve, but the player with an outcome of 2 is not satisfied because he has not reached his greatest outcome. The players will now explore other options.

[13] Garfunkel, Solomon et al., "Game Theory: The Mathematics of Competition," in *For All Practical Purposes: Introduction To Contemporary Mathematics, Fourth Edition*, 15, (New York: W.H. Freeman and Company, 1988), 582.

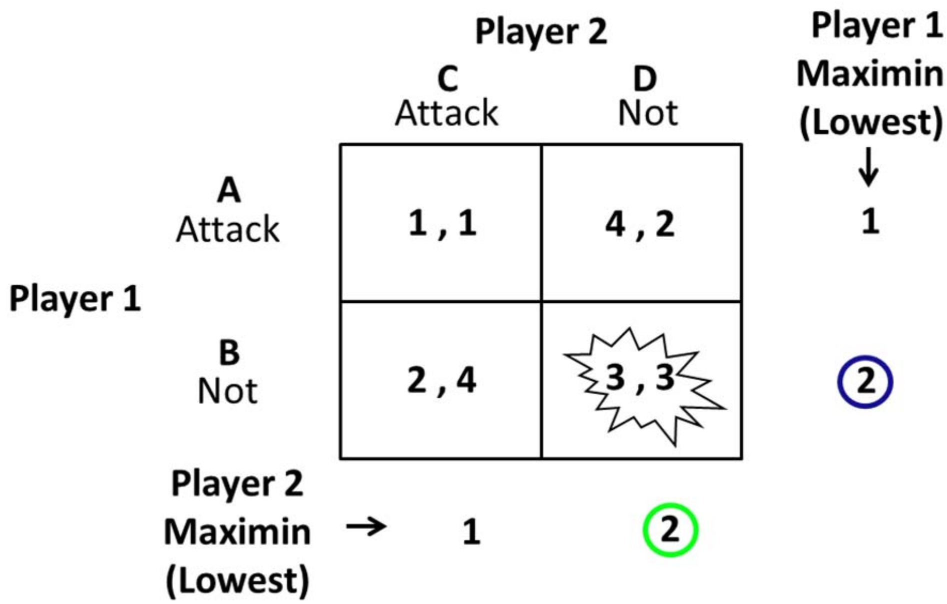

Figure 5. Player 1 vs. Player 2 Maximin

Other options include seeking the maximum value of minimal results. This maximin is determined by selecting the lowest possible outcome between each player's strategies (A , B) and (C , D), as depicted in Figure 5. The highest value is selected as the best possible outcome between the lowest set of values. Notice that if each player is playing conservatively (maximin) without communication, it is in the best interest of each player to not attack (3, 3). Next, the strategic moves each player should consider illustrates how each player can manipulate his opponent in order to maximize his own outcome.

2. Strategic Moves

Identifying some facts about the classic game of Chicken aid in the analysis of strategic moves. Based on the outcome in Figure 5, a dominant strategy does not exist for either player, a Nash Equilibrium occurs at (2, 4) and (4, 2) during a pure strategy game, and the likely outcome without communication would be **(3, 3).**

Opening communication between Player 1 and Player 2 can determine if Player 1 can benefit from a ***first move***.

Should Player 1 move first:

If Player 1 does A, then Player 2 does D, implies outcome (4, 2)

If Player 1 does B, then Player 2 does C, implies outcome (2, 4)

So Player 1 would choose outcome (4, 2), the better option from their perspective.

Should Player 1 **force** Player 2 to move first:

If Player 2 does C, then Player 1 does B, implies (2, 4)

If Player 2 does D, then Player 1 does B, implies (4, 2)

So Player 2 would choose (2, 4), the better option from their perspective.

Player 1 moving first would result in outcome (4, 2), and forcing Player 2 to move first would result in outcome (2, 4). Essentially, Player 1 and Player 2 have a first move that would benefit them individually better than the likely outcome without communication.

In addition to a first move it is important to know if either player has the ability to issue a ***threat***. Threats in the 'game', communicate one player's willingness to impose risk on the other. Suppose the Player 1 wants Player 2 to play D. If Player 2 does C and Player 1 does the opposite of what they should logically do in order to hurt himself, then Player 1 will do A, with outcome (1, 1). Determining that this move also hurts Player 2 reveals that the threat is valid and eliminates an outcome. Player 1 can get Player 2 to choose D with a threat.

To continue the competition beyond threats, determining if Player 1 can issue a ***promise*** will further expand his ability to manipulate the opposing player. Promises in the 'game' are one player communicating how the other player can avoid a risk. Suppose Player 1 wants Player 2 to play D. If Player 2 does D and Player 1 hurts himself by doing B, the resulting outcome would be (3, 3). Since this helps Player 2, Player 1 can get Player 2 to choose D with a promise. However, if both players do not promise, then this move will not work. Player 2 knows he could benefit from not following through with the promise when Player 1 keeps his promise, Player 2 would play C and achieve a (2, 4). Player 1 could do the same and achieve a (4, 2). If both decide to break the promise the

outcome would be (1, 1). For this reason the promise option does not work. In the game of Chicken, "both players would like to move first; in a zero-sum game both players would like the other player to move first."[14]

3. Prudential Security

Since both Player 1 and Player 2 have a first move and a threat, it becomes important to analyze each player's *security level*. The Security Level is the value of the game for each player when using his or her optimal strategy. The Prudential Strategy is the player's optimal strategy to achieve at least their security level. In each "game", the objective is for the player whose game is being analyzed to maximize his outcome while his opponent attempts to minimize the other player's outcome. The result determines a security value for each player.

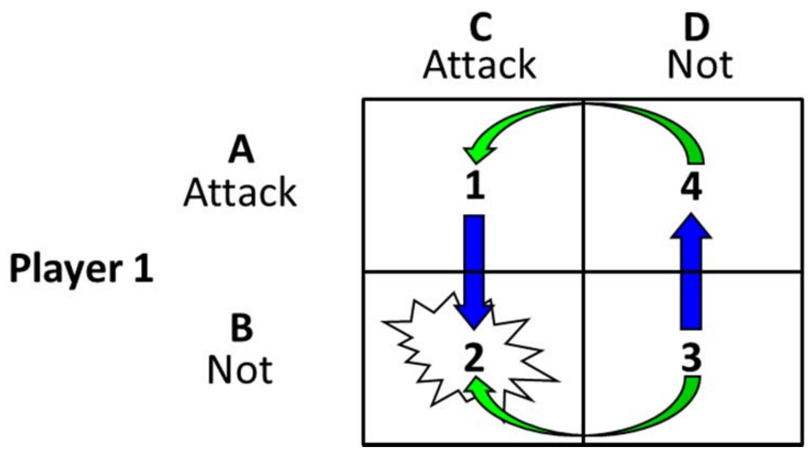

Figure 6. Player 1 Security Level

Figure 6 depicts the results of Player 1's "game" when played alone. Player 1 is attempting to *maximize* his outcome, while Player 2 is *minimizing* Player 1. The prudential strategy is B and the security level for Player 1 is 2.

[14] Philip D. Straffin, *Game Theory and Strategy* (Beloit College: The Mathematical Association of America, 2002), 86.

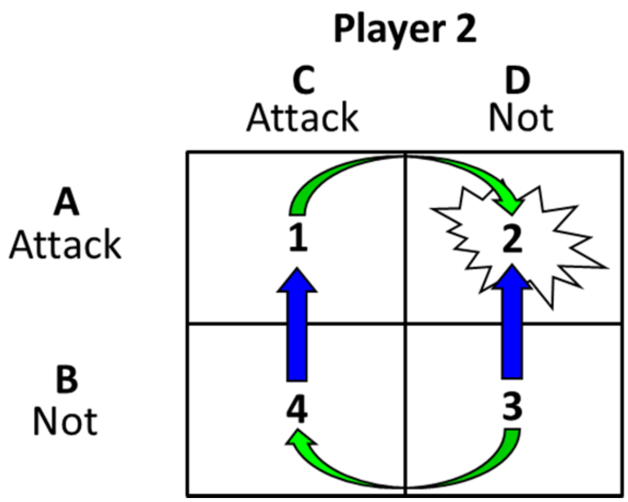

Figure 7. The Player 2 Security Level

Figure 7 shows the results of Player 2's "game" when played alone. Player 2 is attempting to *maximize* his outcome, while Player 1 is *minimizing* Player 2. The prudential strategy is D and the security level for Player 2 is 2.

These two games played individually reveals that the security levels for Player 1 and Player 2 are (2, 2), respectively. Figure 8 illustrates these two security levels when graphed, and demonstrates that the game is partial conflict.

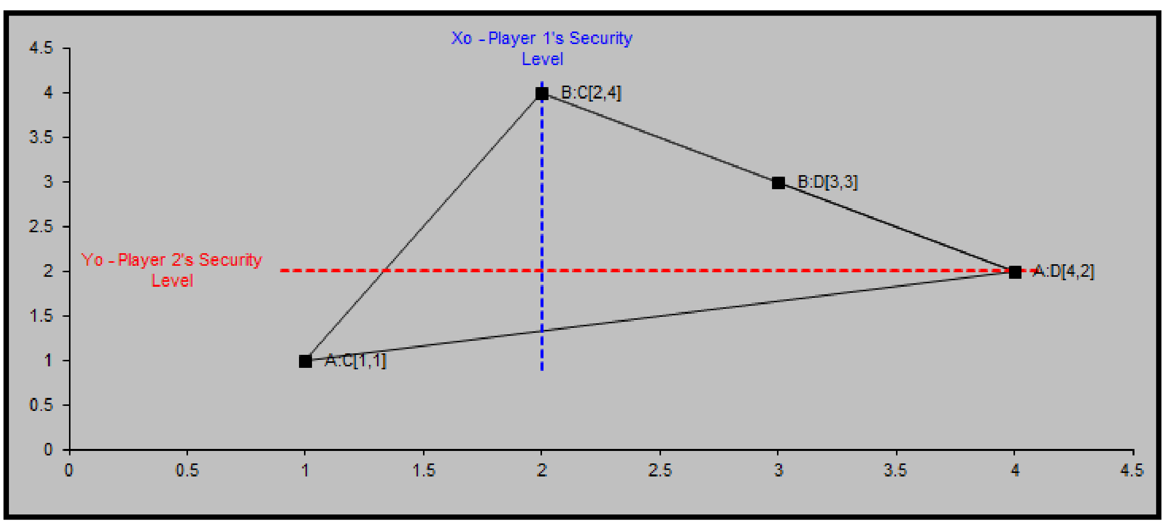

Figure 8. Graphed Prudential Security

The security level reveals to each player to implement a pure strategy. This means Player 1 should always play ‘B’ and Player 2 should always play ‘D’ thus resulting in a (3, 3) outcome. The next important step to illustrate risk in this ‘game’ is to implement interval scaling. While both players could settle on a (3, 3), the value tied to that number determines the willingness of the player to risk a worse outcome to potentially gain a better payoff. How then does the player determine the value of the number in the game? Is the value the same for both players? Determining the value and the probability of achieving said value is subjective to the decision maker.

Subjective notions are important to address when thus far we have only determined risk in an objective manner. Expected value, dispersion, and conditional probability are objective aspects of risk that reveal how risk works, but only determining risk objectively is insufficient. Risk contains aspects of real risk and perceived risk, or objective and subjective components.[15] The known values and probabilities in all of the examples thus far illustrated risk. But if the value and probabilities are unknown and the decision maker must determine them, here enters the subjective aspects of risk. A known value and probability makes weighing risk a simple task, but when subjectively assigning probabilities and determining values the decision maker affects the risk decision.[16]

Returning to the game of “Deal or No Deal,” two players who make decisions differently based on what they value are playing the game. In this example, one player could decide that taking a chance and risking a guaranteed $40 to possibly make $100 is worth it. Player one is a millionaire and losing $40 is inconsequential to him, so he turns to the suitcases to try to make the $100. Player 2 is in a different situation for he is unemployed and has not eaten for three days. A guaranteed forty dollars would allow him to eat and survive. This simple example explains the idea of utility theory in the form of interval scaling. Not every decision maker is the same therefore we must acknowledge the subjective nature of assigning values. Interval scaling accounts for socio-cognitive approaches in the study of risk-decisions where the organizational environment and the

[15] Yaacov Vertzberger, *Risk Taking and Decision Making: Foreign Military Intervention Decisions* (Stanford, CA: Stanford University Press, 1998), 18.

[16] Martin Shubik, “Risk, Society, Politicians, Scientists, and People,” in *Risk, Organizations, and Society*, ed. Martin Shubik (Boston: Kluwer Academic Publishers, 1991), 15.

individual decision maker affect how a decision is made.[17] Each player assigns a value to the outcome of the game that can determine how he makes decisions.

4. Interval Scaling

An interval scale will reflect the weighted preference of outcomes available to Player 1 and Player 2. Straffin states, "A scale on which not only the order of numbers, but also the ratios of differences of the numbers is meaningful is called an interval scale."[18] Figures 9 and 10 illustrate the numbers reflecting the individual preferences of Player 1 and Player 2.

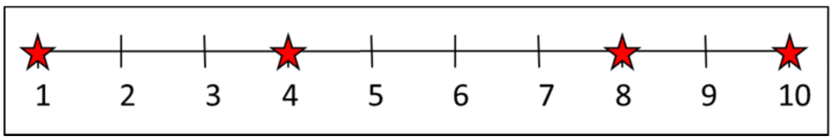

Figure 9. Interval Scaling of Utilities for Player 1 Options

The options available to Player 1 are very clear and ranked accordingly. The best option is awarded a '10' while the least desirable option is designated a '1'.

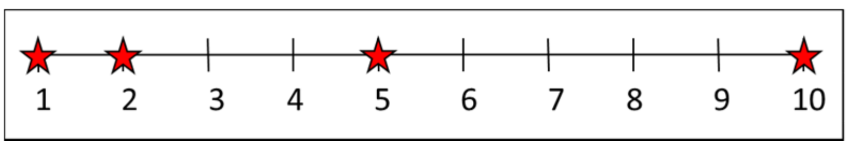

Figure 10. Interval Scaling of Utilities for Player 2 Options

The options available to Player 2 are also indicated utilizing the same scale, but the weight of each option is different than Player 1. These slight differences in how each player weighs the options can present a dramatic difference in the results of the game and the decisions made by each player in the game.

17 Vertzberger, *Risk Taking and Decision Making*, xii.

18 Straffin, *Game Theory and Strategy*, 50.

5. Incentive and/or Negotiation

Decisions each player makes can be determined by the values they assign to their outcomes. The decision to offer incentives and partake in negotiations, in the form of threats and promises, impose risks between the two players. As illustrated in the classic game of Chicken, if Player 1 threatens Player 2 to manipulate him to choose D, he does so with some risk that Player 2 will choose C. That risk is the potential cost of achieving a 1 in an attempt to achieve the benefit of a 4. In other words, the decision of Player 1 could achieve his best or worst outcome based on the decision of the opposing player. This decision can be characterized as highly risky for the decision will yield either his best or worst outcome. Looking closely at the conservative strategy of Player 1 choosing not to attack, we can see how this decision is less risky because no matter what the opposing player chooses, Player 1 will avoid his worst outcome. Comparing the high-risk decision to the low-risk decision depicts the principle that greater risks tend to yield greater possible gain.[19] In this game, the high-risk decision yields a best or worst outcome (1 or 4) where the less risky, or conservative strategy, yields the two middle outcomes (2 or 3). The purpose of the threat is to motivate Player 2 to *believe* that his best option, based on all the factors listed above, is to select the option that is actually not his best option but still achieves part of his desired outcome.

6. Utilities and Risk

Just a portion of his desired outcome may not be the player's goal. Interval scaling can account for the subjectivity of the player by assigning value to his potential outcomes, revealing even more about risk decisions. Table 3 depicts how we apply the utilities of each player based on their interval scale. The players are both positioned at (3 , 3) and weighing the benefits and risks of moving to their best outcome.

[19] Baruch Fischhoff and John Kadvany, *Risk: A Very Short Introduction* (New York: Oxford University Press, 2011), 26.

	Outcome 4 on Interval Scale	Outcome 3 on Interval Scale	Benefit
Player 1	10	8	10 - 8 = 2
Player 2	10	5	10 - 5 = 5

Table 3. Utilities of Each Player Based on Interval Scaling

Player 2 has more to benefit than Player 1 in attempting to move from outcome 3 to outcome 4. Table 4 depicts the risk of each player where in attempting to achieve their best outcome of 4 there is potential that they will achieve a 1.

	Outcome 1 on Interval Scale	Outcome 3 on Interval Scale	Risk
Player 1	1	8	1 - 8 = -7
Player 2	1	5	1 - 5 = -4

Table 4. Risk of Each Player Attempting to Achieve Their Best Outcome

These results determine that to achieve their best outcome Player 1 will only benefit 2 points at the risk of 7 while Player 2 can benefit 5 points at the risk of 4. Player 2 has less to lose and more to benefit, therefore he is more likely to attempt to achieve his best outcome. Application of utilities on an interval scale depicts how different players will be more or less satisfied with their outcomes based on how they subjectively assign values to the outcomes.

D. CONCLUSION

Expected value, dispersion, and game theory are ways to better understand risk in an attempt to improve decision making processes. Identifying the decision to be made, determining if the decision is objective or subjective, and deciding when to make the decision are three portions of a decision making process derived from mathematical principles. Exploring the details and dynamics of risk and decisions reveals that the

method of decision making is not circumstantial, but the answer will be. When all decisions must be made absent from the knowledge of the results, knowing the variables that affect the decision, knowing some of the possible outcomes, and knowing how risk affects the outcomes creates a more sophisticated decision maker.

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III. RISK IN MILITARY TRAINING

The dynamics of risk are poorly understood and no other area of military decision-making illustrates this more than training. The aim of this chapter is to reveal some aspects of risk in training, how it is different from risk in combat operations, and why risk in training and risk in combat should be weighed together.

First, the primary difference between accepting risk in training from accepting risk in combat is the source of the risk. Namely, risk in training is natural risk, or risk that is inherent to the environment. Risk in combat operations includes natural risk as well as risk imposed by an adversary, which will be covered in Chapter IV.

Second, planning training with the primary objective of avoiding risk, not mitigating risk, leads to more risk in combat. Avoiding risk increases risk because there "are no risk-free choices, including not to decide," therefore avoiding risk is simply procrastinating instead of mitigating the risks.[20] When a leader faces the unavoidable risks inherent in combat he will not know how to mitigate them, creating a truly risky situation. This added risk from avoidance is a significant factor that can degrade preparation of units in training when attempting to simulate the conditions of combat.

Third, the primary focus of training is to create the capability to perform duties in changing operational environments. Unit and individual tasks must be executed with a proficiency that changes little with the added risk from an adversary in combat.

Fourth, risk faced in training mitigates risk in combat, overtime. When a soldier faces and mitigates a risk in training, fully understanding the governing dynamics and sources of the risk instead of simply avoiding the risk through safely controlled scenarios, he is better prepared when faced with risks that cannot be avoided in combat. The economic model of supply and demand, when applied to training and combat risk, aptly depicts these four points. The model displays how training and combat risk are different, but are best weighed together. The dynamic model will illustrate examples of different military units with varying probabilities of going to combat.

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[20] Vertzberger, *Risk Taking and Decision Making*, 25.

A. SOURCES OF RISK

Understanding the source of risk is important in the overall understanding of the subject. The aspects of risk inherent to the environment encompass natural risk. These are risks present in training and combat. Natural risks are the only risks in a training environment, for training involves no adversary. Examples of natural risk are weather, terrain, environmental hazards like disease and sickness, and the risks inherent to soldiering like carrying heavy weight or maneuvering. In combat, the risks imposed by an adversary are added to the natural risk. Most often in combat one side is indigenous to the environment and the other is not, which reveals inherent advantages in adjusting to risk. Understanding how one side has an advantage depending on the source of the risk reveals important aspects of risk vital to training and mitigating risk in the military.

Getting beyond the ability for the fighting force to adapt to the natural risk in combat starts with understanding risk in training. Although the essence of the sources of risk is present in Army doctrine, other parts of doctrine complicate this point. The military assertion that we must "train as we fight" clouds the notion that training can never fully replicate combat. Even with simulations, live-fire training, and force-on-force exercises, combat is never exactly the same as training. FM 7–0 *Training for Full Spectrum Operations* notes "'Train as you fight' means training under the conditions of the expected operational environment."[21] The conditions of the operational environment would include the enemy, yet it is impossible to train with a thinking enemy that is attempting to impose risk upon opposing forces in the same way he would in combat. Clarification in our doctrine or further development of our leaders to recognize that the "conditions of the expected operational environment" do not include the full realism of the enemy but only anticipated enemy tactics coupled with replicated environmental conditions is the best way to understand how to train.

More important to understand than a doctrinal slogan is that when a unit deploys to combat not trained it incurs more risk in combat than if it is trained. This statement seems obvious, yet it is a common mistake in our military that when units face a task that

[21] U.S. Army, Field Manual 7-0 *Training for Full Spectrum Operations* (Washington, DC: Army Publishing Directorate, 12 December 2008), paras. 2-23, 2-5.

they have not trained on they are expected to rely on the flexible nature of the soldier coupled with his unwavering will and courage to overcome his lack of training. This may be possible, but to be unaware of the increased risk to both our mission and our forces when they address a problem that they have not faced before or have little knowledge of is negligent. Even more troubling is when leaders widely understand the risky nature of combat, yet expect leaders at the tactical level to anticipate and mitigate risks they have never faced before.

The counterinsurgency training of the U.S. Armed Forces before the war in Vietnam is an example of how a lack of training leads to an increase in combat risk. The Army at all levels failed to adequately educate its members on guerrilla warfare and counterinsurgency. In his work *The Army and Vietnam*, Andrew Krepenevich writes about the disconnected nature of the post-WWII Army leadership with the specific strategic guidance from President Kennedy to focus on counterinsurgency and guerrilla warfare. Army generals appeased the President, but due to their conventional nature they only created a façade of training. Not only was the training inadequate, but the trainers were not experts on the subject of counterinsurgency. Only after 1965 did the Army increase its counterinsurgency training based on the clear commitment of the U.S. to address the regional problems in Indochina.[22] Still "it is easy to understand how the Army entered the war so unprepared in 1965."[23] This unpreparedness incurred an increased risk throughout the war.

Conversely, a good example of how incurring training risk can provide valuable insight to decrease combat risk occurred at Slapton Sands in April of 1944. In an effort to simulate combat risk, Allied forces conducted a live-fire amphibious landing rehearsal off the coast of England at Slapton Sands in preparation for D-Day. This operation, named Exercise Tiger, revealed some valuable lessons that the Allied forces used to adjust their planning for D-Day.

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[22] Andrew F. Krepenevich, Jr., *The Army and Vietnam* (Baltimore, MD: The Johns Hopkins University Press, 1986), 49–53.

[23] Krepenevich, *Vietnam*, 55.

First, Exercise Tiger revealed the poor coordination ability between the Army and Navy.[24] This poor coordination occurred when the *HMS Hawkins* received word to shift H-hour and delay the naval bombardment due to a delay from the landing force. Not all of the landing force received this order and some boats were landing as the naval bombardment impacted the beach, forcing observers to stop the firing.[25] MG Leonard T. Gerow, the V Corps commander observing the exercise concluded that once H-hour is set it must never change because of the confusion that will arise.[26] More important than mere confusion was that a change in H-hour could cause the landing force to loiter within range of the enemy beachhead, causing a severe loss of life.

Second, GEN Dwight Eisenhower learned another valuable lesson from the exercise that directly contributed to the planning for D-day. Eisenhower noted the accuracy of the bombs on target, prompting him to consider bringing the landing force 500 yards closer than the original 1500-yard restriction. As he stated this to LTG Omar Bradley, a plane dropped its bombs 500 yards short, confirming the commander's original assessment.

These lessons came at a high cost due to the coordination issues and an attack from Nazi E-boats sank two LST ships, ultimately resulting in the death of 441 soldiers and 197 sailors.[27] Despite these losses the cost could have been greater. Eisenhower feared that some officers with the knowledge of the actual D-day plan code named Operation Neptune could be captured by German forces after the sinking of the LSTs. In addition, the maneuver of 30,000 troops around the English Channel could have completely compromised the D-day planning. Exercise Tiger pushed the limits of training risk.

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[24] Carlo D'Este, *Eisenhower* (New York: Henry Holt and Company, 2002), 515.

[25] CAPT (USNR) Harry C. Butcher, *My Three Years with Eisenhower* (New York: Simon & Schuster, 1946), 528.

[26] Butcher, *My Three Years*, 529.

[27] Samuel Eliot Morrison, *History of the United States Naval Operations in World War II, vol. XI, The Invasion of France and Germany* (Edison, NJ: Castle Books, 2001; New York: Brown and Company, 1957), 66.

CAPT Harry Butcher came away from Exercise Tiger "feeling depressed" but aptly notes in his memoirs that "frequently the poorest kind of exercise presages the best actual operation because the failures are noticed and corrected."[28] Ultimately Butcher was right due to a glaring and ironic fact that more lives were lost during Exercise Tiger than during the landing on Utah Beach, the D-day objective that Tiger was designed to prepare for. It is foolish to declare that the loss of life in Exercise Tiger directly spared lives in combat, but the lessons gleaned from the mistakes in training did decrease the combat risk of the D-day landings.

B. THE RISK OF AVOIDING RISK

Preparing for the right task in the wrong way is how poor training can increase combat risk. Risk avoidance is often the method leading to this failure resulting in the self-perception that a unit is trained, but is not. Strict control of training environments is a method of risk avoidance that prevents units from facing risks. Yaacov Vertzberger writes in his book *Risk Taking and Decision Making*, "The broader view of risk should take into account the chance that risk avoidance in the short run may turn out to be a very risky decision."[29] Risk avoidance is more risk taking than risk avoiding. Vertzberger includes examples of strategic decisions on whether or not to deploy troops. He writes that deciding to avoid risking troops lives could allow a small security problem to get bigger and in the long run risk more troops when they are eventually mobilized.[30]

Another example of the risk incurred from risk avoidance occurs in the military training approach to fire missions. This risk-avoidant approach to fire missions resides in avoiding training "danger close" missions that can occur in combat. *JFIRE: Multi-service Tactics, Techniques, and Procedures for the Joint Application of Firepower* (*JFIRE*) is a compilation of field manuals from all military services that addresses danger close in two ways. First, danger close is included in the "method of engagement" line of a call for fire request to indicate that friendly forces are close to the target. Second, aircraft delivery of

[28] Butcher, *My Three Years*, 529.

[29] Vertzberger, *Risk Taking and Decision Making*, 25.

[30] Vertzberger, *Risk Taking and Decision Making*, 25.

ordnance inside 0.1%, or 1 out of 1000, Probability of Incapacitation (PI) distances are considered danger close.[31] Danger close is a term that is exclusive from Risk-Estimate Distance (RED), although the RED for 0.1% PI is used to define danger close for aircraft delivery. Danger close is also exclusive from the Minimum Safe Distance (MSD) that is utilized for "peacetime training."[32]

Important to note here is how the bureaucratic nature of the military can easily contradict itself through doctrine. The *JFIRE* manual states that danger close fire missions are permitted in combat but forbidden in training.[33] Yet, the Army Field Manual 3–21.10 *The Infantry Rifle Company*, plainly states that "[i]f required, the company commander can even call for artillery fires right on his company position using proximity or time fuses for airbursts."[34] On one hand the doctrine restricts the training of danger close missions and on the other hand it outlines danger close missions as a tool for a commander in combat. These two manuals are fundamental to maneuver warfare while also conflicting in their guidance. This conflicting guidance from doctrine infers the dangerous nature of combat while overly promoting safety in training. Overly safe approaches lead to risk avoidance that causes inadequate training of fires "danger close." Telling a commander that he can call fires on his position in combat but not accepting the risks to properly train him or her to do so is an irresponsible approach to prepare for combat. Excessive restrictions on training a call for fire, caused by risk avoidance, is an insufficient approach to properly preparing commanders for this decision.

The risk avoidant nature of military manuals delineate between training and combat when training is intended to prepare units for combat. Forward Observers and Joint Air Tactical Controllers are required to manage fires from aircraft in the complexity of close battle but due to the training restrictions on fires, the difference in distance

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31 U.S. Department of Defense, *JFIRE: Multi-service Tactics, Techniques, and Procedures for the Joint Application of Firepower* (Washington, DC: Government Printing Office), 105.

32 *JFIRE*, 124–125.

33 *JFIRE*, 105.

34 U.S. Army, *Field Manual 3-21.10 The Infantry Rifle Company* (Washington, DC: Army Publishing Directorate, July 2006), paras. 10–83, 10–21.

between training and fighting can be 1,115 meters.[35] The disparity between the danger close distance and the minimum safe distance has room for adjustment. The *JFIRE* manual bases RED distances on three assumptions: “friendly troops are standing unprotected in the open, in winter clothing and helmet, and on a line perpendicular to the line of fire.”[36] These assumptions do not reflect the reality of combat. Changing the assumptions that are utilized in assessing the risks of danger close fires greatly mitigates the risk while training fire supporters to call for fire at distances similar to combat.

The danger of training at the highly restrictive minimum safe distances prevents leaders from managing the risks of close combat. Leaders may approach fire support in combat in the same manner in which the manual does: a simplistic combination of weapon system, ammunition, and distance, that results in a black and white determination of whether a fire mission poses risk to friendly forces or not. Simple approaches to combat situations can be useful, but simple approaches often lead us to create simple training, focused on risk avoidance, which does not teach leaders how to mitigate risks in combat. This tendency is another example how the common cliché used in military circles that we “train as we fight” is not exactly true. As our Commanders and Forward Observers stand on an open hilltop on a range and squint through binoculars at a safe distance to attempt to see the impact and effect of rounds on the target we must ask ourselves whether this is properly preparing them to make decisions concerning risk in combat.

C. TRAINING PROCESSES FOCUSED ON PERFORMANCE OF TASKS

Preparing to address risk in combat is a training process that requires a unit or individual to effectively perform their tasks. Since training cannot perfectly replicate the conditions of combat, which would include one side taking steps to impose risk upon the other, military units must focus on performing their duties proficiently despite the adverse conditions of the natural environment. Creating training under adverse conditions

35 This determination from the author utilizes the difference between the minimum safe distance (MSD) of 1200m, for peacetime training, and danger close distance of 185m of a GBU-38 500 1b JDAM according to the JFIRES manual.

36 *JFIRE*, 106.

applies a combination of experience and training practices to help units collectively prepare. Army training philosophy realizes the benefit of "training for proficiency" and performing the "fundamentals first" in "challenging, complex, ambiguous, and uncomfortable situations."[37] Creating an environment described by doctrine requires acknowledgment of the risk inherent to the military profession. Military units cannot train as their doctrine guides them while at the same time pretending that the environment they create has no risk. Trainers who control the environment to a degree that reduces the risk to a negligible level actually create an unrealistic situation that ceases to be the environment that will prepare units for combat. Performing tasks well in training under negligible levels of risk provides some benefit, but leaders must acknowledge that it is not the optimal way to train.

D. OPTIMAL TRAINING RISK TO MITIGATE COMBAT RISK

Understanding the inherent risk of combat and training helps trainers tie the two environments together in order to conceptualize an optimal way to train. Leaders can justify the risk in training because risk faced in training mitigates risk in combat, overtime. Viewing training and combat along a continuous spectrum of time will help reduce risk avoidance in training. Leaders will realize that unchallenging training is risky because it does not prepare subordinates for the risk that occurs from performing military duties in different environments. When the risk from adversaries is added upon the natural risk of the environment, units will not be able to perform their duties for they will not know how to mitigate the spectrum of risks imposed on them. Even worse is the tendency that we reward those leaders who do not make mistakes, which fosters risk aversion. The result is a leader who is placed in charge in combat who has performed well in a non-risky training regimen, but has never learned from mistakes so he does not recognize how to mitigate risks. If this leader learned of the inherently risky nature of training and combat by making mistakes in training then he can appreciate how much better prepared he is to face risk during combat operations.

[37] U.S. Army, *Field Manual 7-0*, paras 2-23, 2-5.

On the other hand, creating training plans that are risky without weighing the worth of facing risk to prepare for combat is also an incorrect approach to military training. Leaders should not just take risks for the sake of taking risks. Individuals can vary greatly in how they view risk. Some are risk-takers while others have the tendency to shy away from small risks. The tendency to lean one way or the other is the product of the past that creates a consistent cycle of risk acceptance or risk avoidance. The danger here is to rely solely on individual judgment and not a deliberate decision making process. This process should reveal that at some point the added risk in training is not worth reducing the risk in combat. The basis for this point of diminishing return resides in balancing the level training with the probability of conducting the mission in combat. This idea is better understood by combining training and combat risk to reveal a "net risk" of the two environments. Since economics can help explain human behavior when seeking the best decision, it will help illustrate the relationships of risk in different environments.[38]

E. THE ECONOMY OF RISK

The relationship between training risk and combat risk is similar to the economic principles of supply and demand. Training risk is the amount of risk a unit is willing to "supply" in response to the "demand" of combat risk.

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38 Kingma, *Economics of Information,* 5.

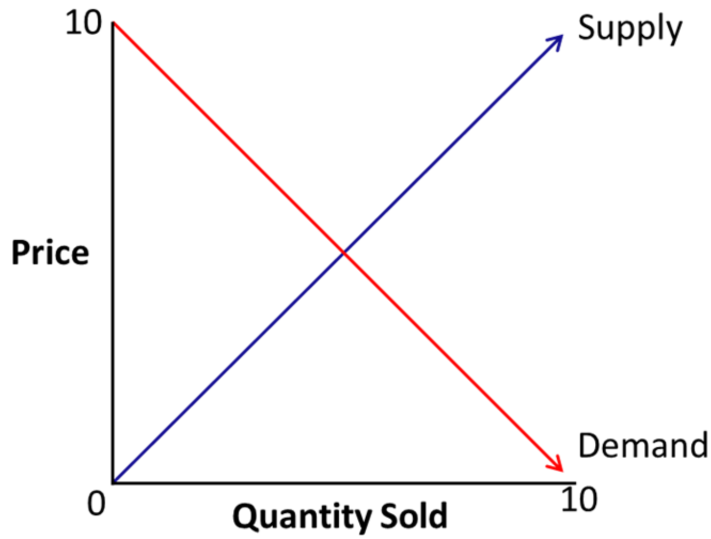

Figure 11. Supply and Demand

Figure 11 depicts a standard supply and demand model that when applied to risk forms the model in Figure 12. A review of the terms of the two figures will help illustrate the connection of the two models and the similarities of their governing dynamics. First, price dictates what something will cost, just as risk is the variance of potential costs in training or combat. The quantity sold at a particular price is similar to training realism at a particular amount of risk because when in a combat environment a unit is essentially "supplying" their skills built in training in the form of their performance as "demanded" by combat. Furthermore, the economic market equilibrium "is a price and quantity that consumers are willing to pay to purchase the amount producers are willing to supply at a particular price."[39] This equilibrium is the optimal point where the amount of training risk and quantity of training realism are at levels that are commensurate with the probability of facing combat. At this point a unit or individual is best prepared for combat at the lowest risk because the net risk is minimized.

[39] Kingma, *Economics of Information*, 46.

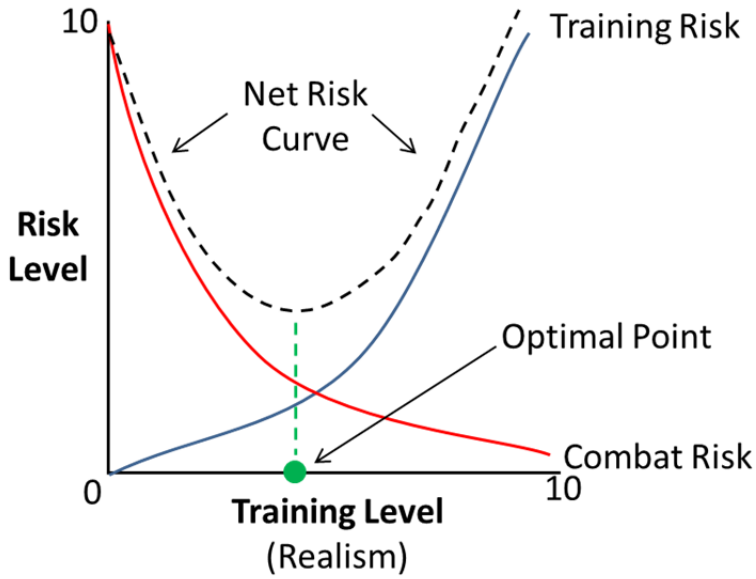

Figure 12. Relationship Between Training Risk and Combat Risk

F. VARIABLES OF THE TRAINING AND COMBAT RISK CURVES

Minimizing risk is what units seek when viewing the combination of training and combat risk. The optimal training level in Figure 12 is the point that minimizes the net risk. The optimal point in this economic model becomes more interesting and sophisticated when discussing what variables change the slope and positions of the training risk and the combat risk curves and can hence change the optimal point. Some variables that change supply and demand curves are the prices of other goods, technology, and expectations.[40] With this risk model, the slope and position of the curves, and the optimal point change primarily based on three variables. First, as the probability of deploying to combat increases, the need for a higher training level increases. These two increases cause a unit to move up the training risk curve toward the optimal point. Second, the type of unit and its mission increases or decreases the slope of the training risk curve. For example, an infantry soldier conducts riskier training than a hospital technician, which illustrates why the slope of the curve changes. Third, the slope of the combat risk increases or decreases based on the type and location of the unit.

[40] Roy J. Ruffin and Paul R. Gregory, *Principles of Economics, Third Edition* (Glenview, IL: Scott, Foresman and Company, 1988), 70, 75.

Different conflicts and different geographical locations within a conflict impose different risks. A medic in an infantry unit in a small outpost in the mountains will have different risk curves compared to a medic in a Combat Support Hospital in the center of a large well-defended base. Examples of different units and different duties within those units will illustrate how variables can change the slope and position of the curves.

In Figure 13, the training risk and combat risk combine to form net risk of the two curves. This model depicts a few nuanced dynamics, namely how training risk reduces combat risk at different rates, training realism increases training risk, and combat risk never goes to zero. No matter what the level of training there still exists an inherent level of risk in combat. In addition, the model reveals the lowest net risk is an optimal point, which notably does not have to occur at the intersection of the training and combat risk curves. The parabolic shape of the net risk curve means that the minimum risk occurs when the slope of the curve is zero, its lowest point. Furthermore, the graph in Figure 13 depicts an Infantry Battalion that is *not scheduled* to deploy. This is important because the combat risk level assumed by the unit increases as the probability of deploying to combat increases. Figures on subsequent pages will illustrate this conclusion.

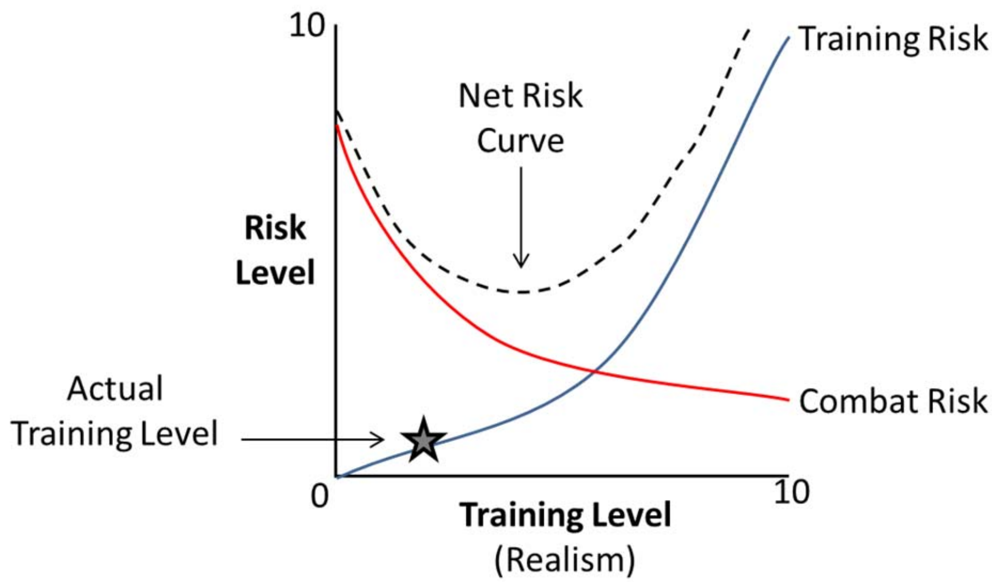

Figure 13. Risk Levels for an Infantry Battalion Not Scheduled to Deploy

The first dynamic that training risk reduces combat risk is obvious. What is not obvious is the rate at which training can reduce combat risk, which is depicted in this model for the Infantry Battalion. In Figure 13 the relatively flat training risk curve that occurs at a low level of training realism and the corresponding steep downward slope of the combat risk curve depict how a small amount of training can quickly reduce combat risk. For example, there is a significant contrast between soldiers with no marksmanship training who are sent into combat versus soldiers who are trained on a range for just six hours. The first soldier may not know how to load, aim, or fire the weapon while in a short period of training the latter could conceivably hit targets within a hundred meters.

While time training on a range reduces the combat risk, training risk increases as training realism in the context of combat increases. The training risk increases with more complex tasks in order to increase the level of proficiency of soldiers that combat requires. An example for the Infantry Battalion is a company live-fire that simultaneously integrates external indirect fire support from artillery and fire support from aerial assets such as helicopters and fixed-wing aircraft. These complex training events seek to increase the ability of a Commander to manage his own assets on the battlefield, without the presence of an enemy firing back. Even without the enemy imposing risk, the training risk is very high (more on the right side of the training realism scale). But this training event greatly reduces the combat risk by increasing the unit proficiency at tasks they must perform in combat.

Although reducing combat risk through realistic training is the goal of units preparing for war, there exists a level of combat risk that will always remain. Combat is inherently risky and even the most proficient soldiers often face risks that can be insurmountable. A commander who has proficiently managed his own maneuver elements, has conducted realistic training that integrates external assets in conjunction with his maneuver, and has a deep understanding of the enemy force and its capabilities still has the potential of losing troops or failing to accomplish the mission. The factors of natural risk, like the weather or terrain, or risk imposed by the enemy, like planting an IED or infiltrating the commander’s defenses, are risks that still exist at a certain level that no amount of training can reduce to zero.

Despite the minimum level of combat risk that remains exclusive from training, an optimal point in the relationship between both risk environments is important to explore. This key point is where the slope of the net risk curve is zero and is the optimal training level and risk level in the context of a unit that is designated for combat. Below the optimal point the training level has not reached a point that has significantly reduced the combat risk. Economically speaking this is a shortage, where the quantity demanded exceeds the quantity supplied.[41] A shortage will produce a unit that has poorly prepared for the tasks it will perform in combat or a unit that is well trained on tasks it will not perform in combat and is therefore unprepared for war. Beyond the optimal point the risks associated with training realism are not worth the cost because it reduces combat risk at a lower rate and the net risk begins to increase. This is a surplus, where the quantity supplied exceeds the quantity demanded.[42] Risks are simply being taken when they do not need to be.

Understandably, assuming risk to prepare for combat without having the potential of deploying to combat should change the risk a unit is willing to take in training. This change creates a rational reduction in training level, in a sense avoiding a surplus. Avoiding a surplus rationally explains why a nation not at war has the tendency to become risk averse. Unfortunately leaders fail to recognize that the lower probability of combat rationally necessitates a reduction in training risk. Instead leaders conduct risky training under tight levels of control that creates the perception of being prepared that may rationally be a waste of resources in light of the low potential of future conflict.

[41] Ruffin, *Principles of Economics*, 78.

[42] Ruffin, *Principles of Economics*, 79.

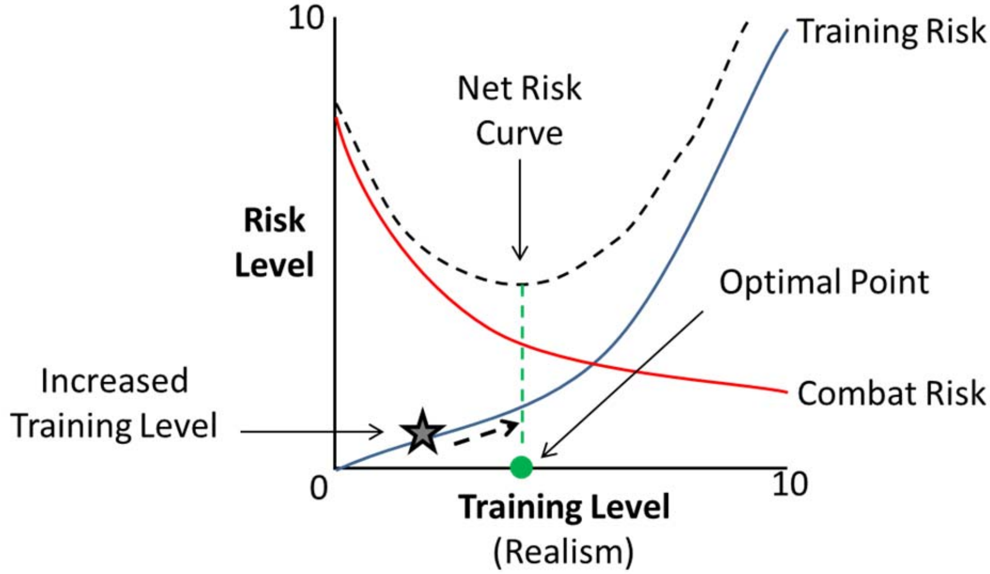

Figure 14. Risk Levels for Infantry Battalion Scheduled to Deploy

Despite this rational tendency, the star in Figure 14 depicts the ideal training level of a unit that is not designated for combat. As the potential for a combat deployment increases the level of training for the unit should move toward the optimal point as depicted by the arrow in Figure 14. Moving toward the optimal point increases training risk and realism as combat risk is reduced. In a sense, the probability of combat requires the supply of training to go up to avoid a shortage. Conversely, as the probability of combat goes down risks in training go down to avoid a surplus. While the optimal level is a point that is ideal when combat is certain, trainers reduce training risk as probability of combat goes down.

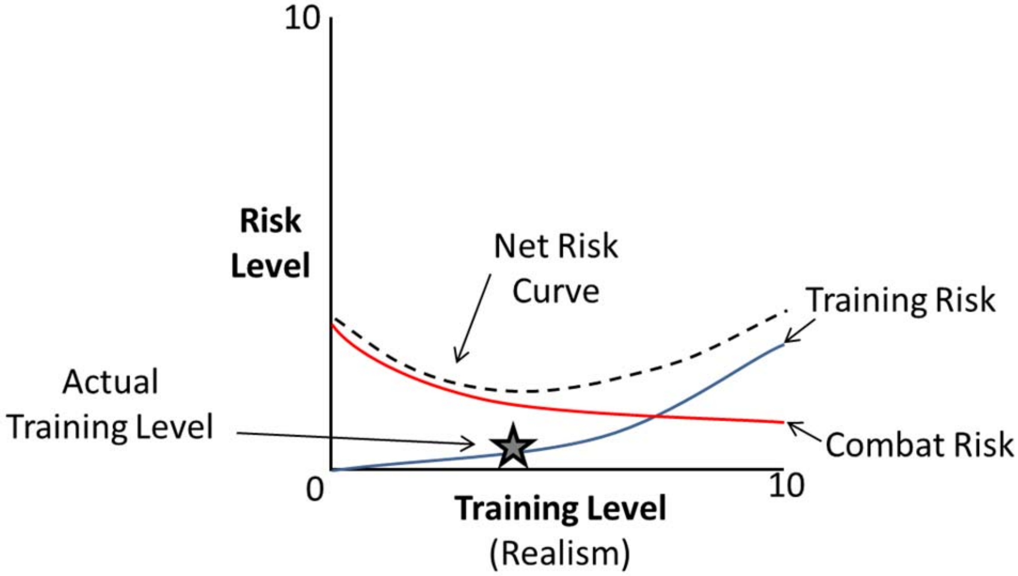

Figure 15. Risk Levels for Peacetime Combat Support Hospital

In contrast to the infantry battalion, the curves of the Combat Support Hospital model in Figure 15 are different based on the tasks performed in combat and the specialty of different soldiers. The curves are flatter and lower on risk level compared to an infantry unit. The flat curves depict the complexity of the task of medical personnel. Medical tasks require more time to train, unlike spending a few hours on a range, yet are relatively low risk in the context of combat because they are normally placed in safer areas protected by combat troops. The relationship between training risk and combat risk are tighter, meaning that the tasks they perform during peacetime and in combat are in very similar environments in this case a hospital. The inherent level of combat risk in a Combat Support Hospital is significantly lower than those faced by the infantry, but a minimal level still exists in the environment. Risks from indirect fire or the enemy attacking a large base is low but still possible.

Even though the Combat Support Hospital deals with lower risks to soldiers, its optimal point should still be viewed in the context of the potential of going to combat.

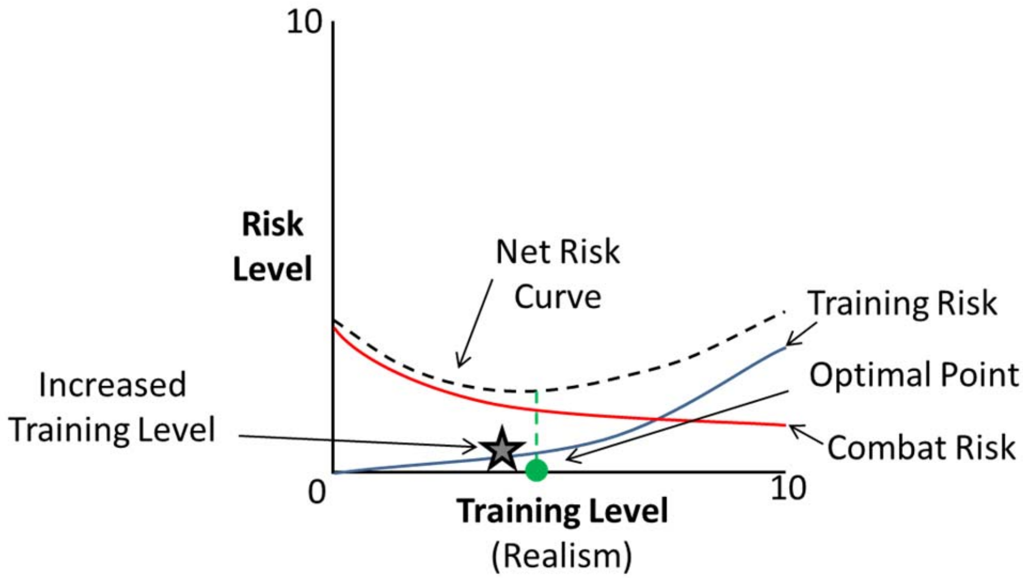

Figure 16. Risk Levels for Wartime Combat Support Hospital

The star in Figure 16 shifts along the arrow as the probability that the hospital unit goes to combat increases. Here the training level is relatively close to the optimal level and only requires a small shift to optimize. The costs to the hospital unit are different based on the job specialty. These costs oftentimes involve acquiring more expensive equipment and specialty personnel that are seldom utilized outside of combat as the probability for combat increases. Due to high cost, the risk of using expensive equipment in the hospital is not worth training on unless the potential for combat has reached a certain level.

This optimal level is important because it provides a way to understand the many errors that military trainers make in managing training in the context of combat. Military trainers desire to maximize the training level of their units often without analyzing if the tasks they are training are reducing combat risks. Even more intricate is to understand that some tasks reduce risks in combat at a greater rate and should be prioritized over tasks that reduce risks at a slower rate. Furthermore, the level of training for combat should be in the context of the Military Operational Specialty (MOS) of the individuals. The idea that "Every Marine is a Rifleman" or that all soldiers should be trained like an

infantryman is inefficient in the context of preparing for combat. Although these slogans exhort branches of the military to rally around a mantra of a fighting force and to emphasize the minimum standard for all Marines or soldiers in combat, trainers must balance the standard for fighting and training specialty duties on the tactical level. If training a particular MOS involves skills outside basic soldier tasks or skills beyond the individual soldier specialty then trainers are training incorrectly. For example, the medic training to employ a claymore mine instead of training how to stabilize a casualty or the mechanic that is learning about explosive breaching instead of learning the proper way to troubleshoot a tank often is the result of trainers mismanaging how they prepare soldiers for combat.

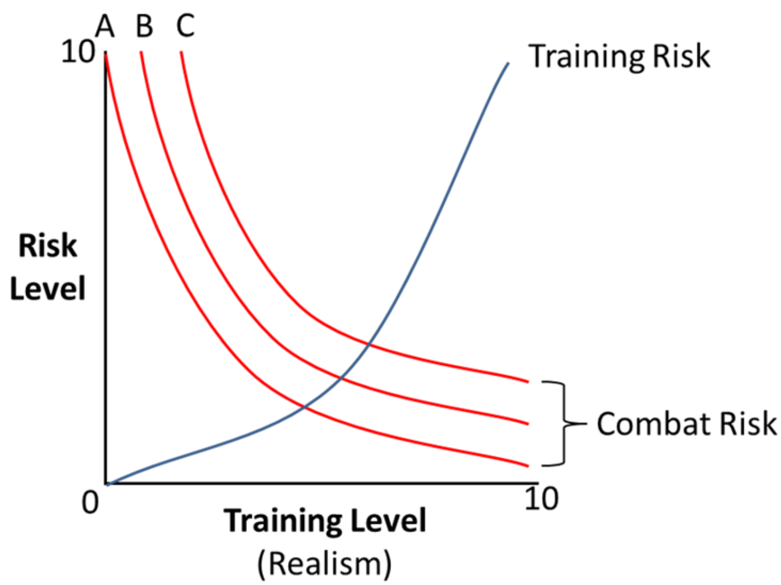

Figure 17. Combat Risk Curve Shift

Another way to depict the increased combat risk due to the increased probability of going to combat is an actual shift of the combat risk curve. Figure 17 shows three different positions of the combat risk curve that represent the combat risk to three different types of units from least to greatest risk. For illustrative purposes, Unit A can be the National Guard, Unit B can be the 82nd Airborne Division, and Unit C can be a Special Missions Unit. Unit A has no planned combat deployment in their future. Unit A therefore does not need to prepare themselves for combat to the same level of readiness

as Unit B. Unit B represents a unit who could possibly deploy and must be ready, yet the frequency that they are deployed is not very high. Finally, Unit C knows they will deploy and the readiness of their unit is based on routine and frequent deployments to combat that demands and increase in their training level and their risk level.

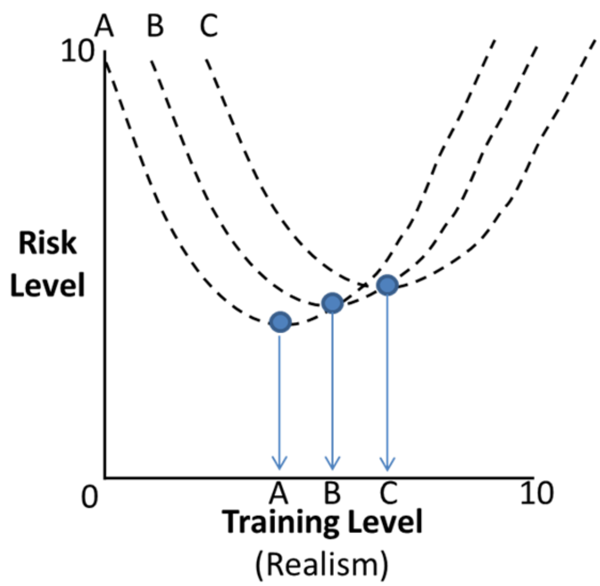

Figure 18. Net Risk Curve Shift

Figure 18 represents the net risk level of each of the units in Figure 17. As the combat risk curve shifts with the increased probability of combat the net risk also increases. Not only does the combat risk curve change based on the duty of the individual, as with the Infantryman and medic within the Combat Support Hospital in previous examples, but it can also change based on the type of unit and their associated potential for combat. In other words combat risk changes based on duty position and unit.

G. CONCLUSION

A deeper knowledge of the dynamics and sources of risk will help prevent the potential for mismanagement of training and optimize resources and time in preparation for combat. The conclusion here is that the source of the risk in training and in combat is not the same. Training includes natural risk while combat compounds natural risk with risk from an adversary. Since risk from an adversary can only be truly appreciated in

combat, training focuses on doing tasks well in difficult environments. Conducting tasks and processes well leads to another discovery that training mitigates combat risk therefore it is best to view risk in these two different environments together. The economic model of supply and demand provides a clear methodology to understand the complexity of the relationship between the two risk environments. The model shows how training to mitigate combat risks involves a certain amount of training risk that increases as training realism increases. Just as supply and demand curves change with different factors, training risk and combat risk curves change position based on the probability of combat and change slope based on the tasks a unit or individual is trained to perform. Viewing the two risks environments together should ultimately help trainers resist the tendency to avoid risk in training, which is more risky because it fails to reduce combat risk. These conclusions will help leaders and trainers manage expectations and resources in preparation for combat in a more sophisticated way. The aim here is not to provide a solution but a more analytical process for creating a solution. Ultimately this will help trainers avoid preparing for the wrong task or avoid preparing for the right task in the wrong way.

IV. RISK IN COMBAT

For centuries, warrior scholars have attempted to understand the dynamics of conflict where two or more adversaries impose risk on one another while also addressing the risks natural to their environment. Utilizing decision theory with two competing decision makers will aid in revealing the complexity of decisions in combat. A rigorous exploration of how adversaries impose risk on one another through an abstract example followed by a series of applications expose three main points. First, outcomes of decisions are determined by multiple variables but all variables do not affect the outcome with equal weight. A sound decision process helps identify how each variable affects the outcome and which variables should be the focus to make the right decision. Second, the decision criteria should determine how decisions are made. Decision criteria is also referred to as decision strategy that focuses the decision maker to make decisions based on what he values in the outcome. Third, understanding risk is central to decision-making because risk is part of every decision and it depicts the difference between the best and worst outcome.

Beyond these three main points many errors occur in decision making that greatly affect the ability of the military to make decisions effectively. Policies established by higher-level commands can prevent lower level leaders from even having the power to make decisions in certain combat situations, which greatly inhibits the ability to manage a battle. This point exposes the shortfalls of centralized control while advocating for de-centralized control in light of inherent risks involved in both methods. Additionally, policies that inhibit choices establish a status quo that creates a cyclical pattern where little freedom exists to break the cycle. These cycles often include repeating mistakes in strategy and often come at a high cost before they are changed. Evidence of these errors is displayed throughout this chapter through abstract examples and then specific and common instances. The aim of this chapter is to provide an example of a decision process that will aid military leaders in bolstering their decision-making through the proper identification of the right variables. This process will also help identify the risk and the decision criteria to create deeply knowledgeable decision maker.

The first step in illustrating these three main points involves returning to the principles established in Chapter I. Recalling the game of Deal or No Deal will aid in illustrating some sophisticated principles of expected value using decision theory. The purpose of this example is to introduce the format of a decision tree (in other examples a game tree) and the two strategies or decision criteria that will be used in subsequent examples.

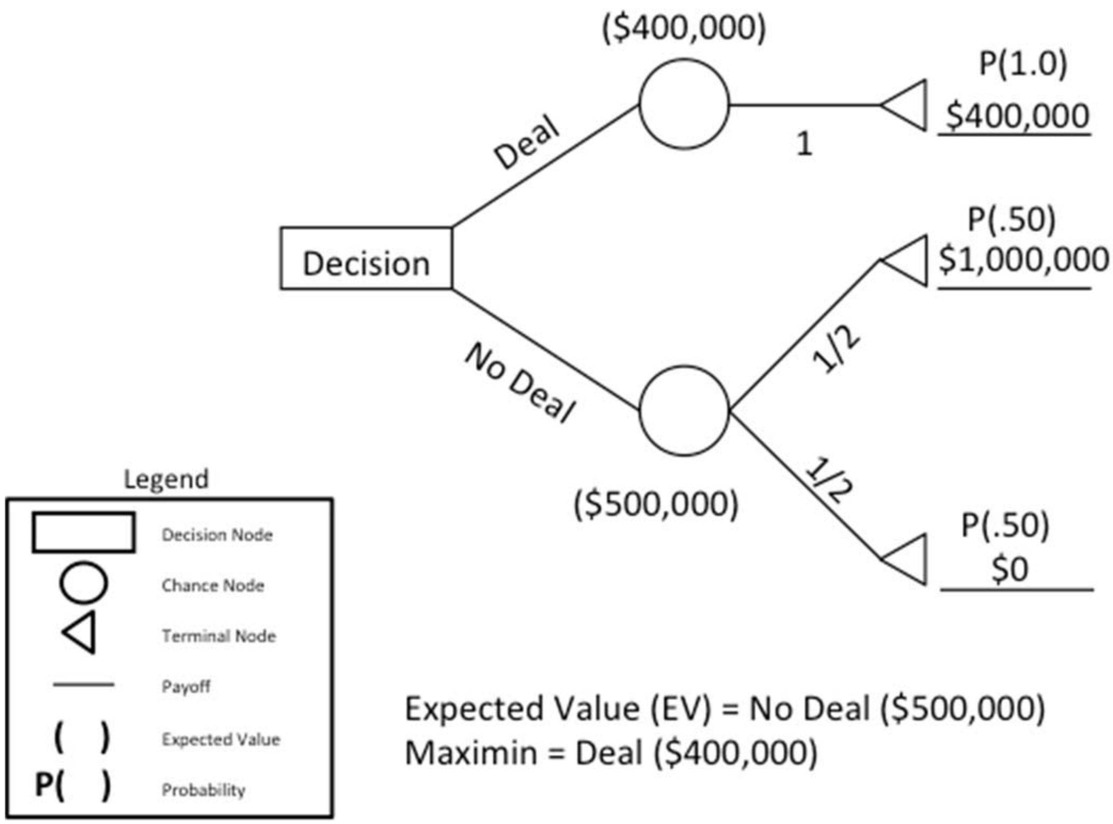

Figure 19. Decision Tree Example Where Expected Value is Greater Than Maximin

Figure 19 is a decision tree of the contestant. The first decision node depicts the decision of the contestant to choose the offer of $400,000, the Deal, or to select No Deal. Choosing No Deal will subject the contestant to a probability. The 50 percent probability determines the expected value of $500,000 (E(X)= .5(0) + .5($1,000,000) =$500,000), which is greater than the $400,000 (E(X) = 1($400,000) = $400,000) offer from the

banker. Even with the greater expected value of the No Deal option, selecting the guarantee of $400,000 would be a *maximin* strategy where a player selects the option that maximizes their minimum gain. A maximin strategy is often the more prudent choice in one-time decisions. Sometimes a *minimax* strategy is a better option where the player seeks to minimize their maximum loss or avoid their worst outcome. If the contestant could play this game one hundred times, or for the long haul, then expected value would be the better strategy that would maximize his payoff.

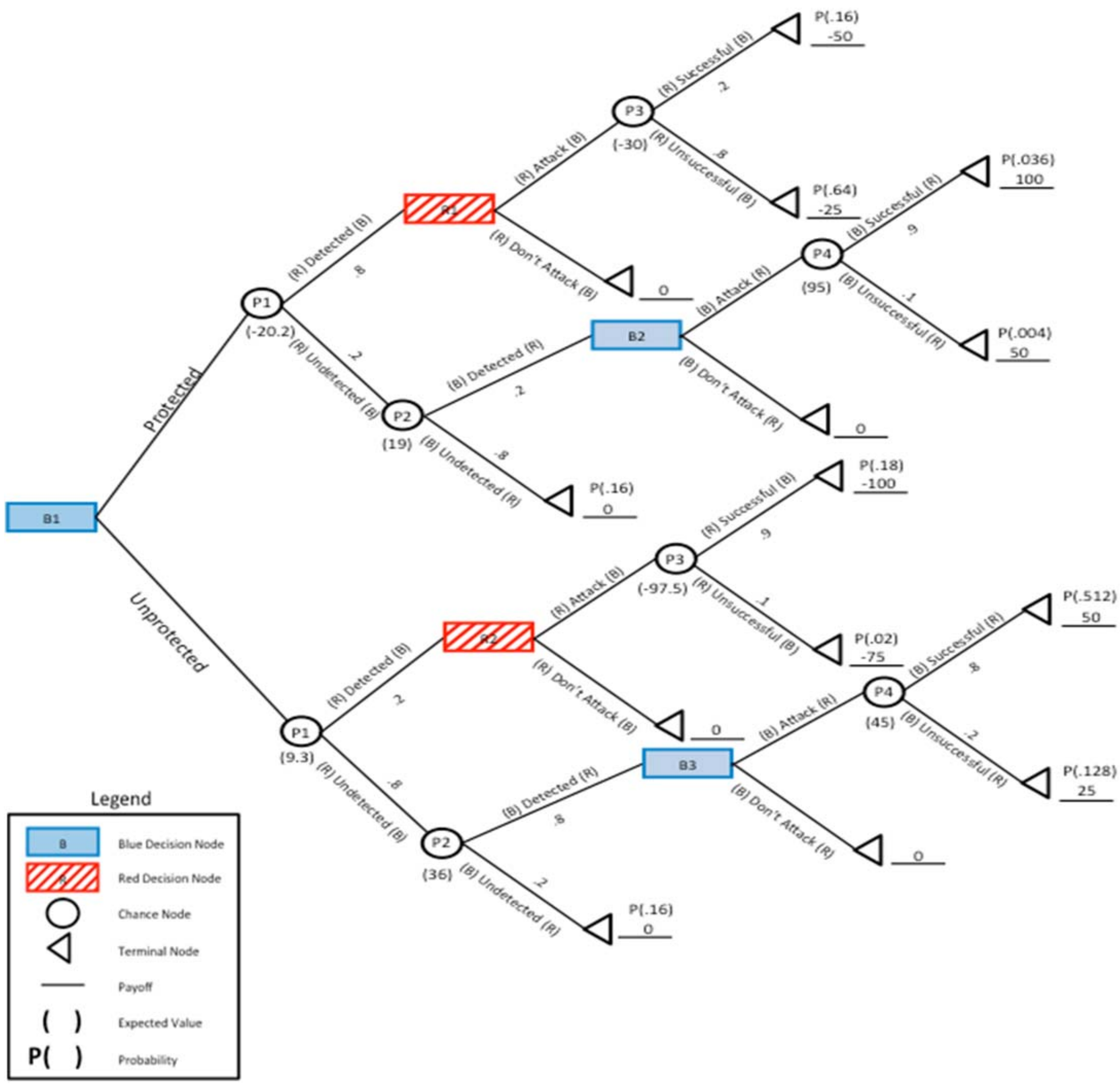

Figure 20. Protected or Unprotected Game Tree

A. THE “PROTECTED” OR “UNPROTECTED” DECISION

The game tree in Figure 20 depicts the combination of decisions and probabilities that result in outcomes with an associated payoff for each player in an armed conflict. In this example the opposing players, Blue and Red, make decisions to maximize their payoffs. A square node is a decision made by either Blue or Red and the circle node is a probability that occurs as a result of that decision. The decision or the result of the probability is written along the line that connects the nodes. The payoff and associated conditional probability is next to the triangle that represents the terminal node. The payoffs in Figure 18 span a utility scale from -100 to 100 and all examples here depict Blue force payoffs where Red’s payoffs while not written in Figure 19 are the negative of Blue’s payoffs. Using the combination of probabilities and payoffs reveals the expected value of each decision. In order to fully understand the depth and scalability of this game tree as an example of a decision process it is essential to determine the assumptions used to formulate the tree, the variables that can change the outcome, and the decision criteria as determined by the nature of the players and the situation.

The assumptions used to formulate this game tree are based on the common practice of each decision maker, the nature of low-intensity conflict, and the experience of the authors. The first assumption is that the Blue player represents a larger conventional force that is less familiar with the specific environment of the conflict but has more resources, superior firepower, and advanced technology. The Red force is a smaller guerrilla or insurgency force that is more familiar with the environment, is more flexible with less technology, and tends to have a tougher force that are warriors by nature.[43] Slight adjustment of the probabilities and payoffs in Figure 18 is subject to debate but it would be difficult for anyone to argue for a drastic change in these values based on the nature of the opposing forces in irregular conflict. After all this set up of the players is the most common structure of conflict since the end of WWII.[44]

[43] Major C. E. Calwell, *Small Wars: Their Principles and Practice* (Watchmaker Publishing, 1899), 125.

[44] Internal War Database, Department of Defense Analysis, Naval Postgraduate School, Monterey, CA, 2006.

The second assumption concerns the first Blue force decision. Selecting Protected assumes increased survivability and lethality for the Blue force while sacrificing stealth and surprise. If Blue chooses to be Unprotected he chooses less lethality and survivability but also reduces his chances of detection by choosing a posture to remain hidden as a member of the Blue force. The third assumption is that both Blue and Red seek to maximize their outcomes. This means that each player will attack upon detecting the other player because it will yield a higher payoff. Those payoffs are highly contingent on the fourth assumption that Red has the first opportunity to detect Blue. If Red does not detect Blue based on the probabilistic outcome then Blue has an opportunity to detect Red.

These assumptions are important when determining the probabilities and payoffs for each variable in the game. The probabilities and payoffs associated with the variables are what change the outcome of the game and can be adjusted upon a change of the situation of conflict. Here, the variables are protection, detection, and success of attack. Breaking down Figure 18 into the Protected branch of the game and then the Unprotected branch of the game will aid in explaining the probabilities and payoffs associated with each outcome, their frequency, and how the variables can change within the decision process.

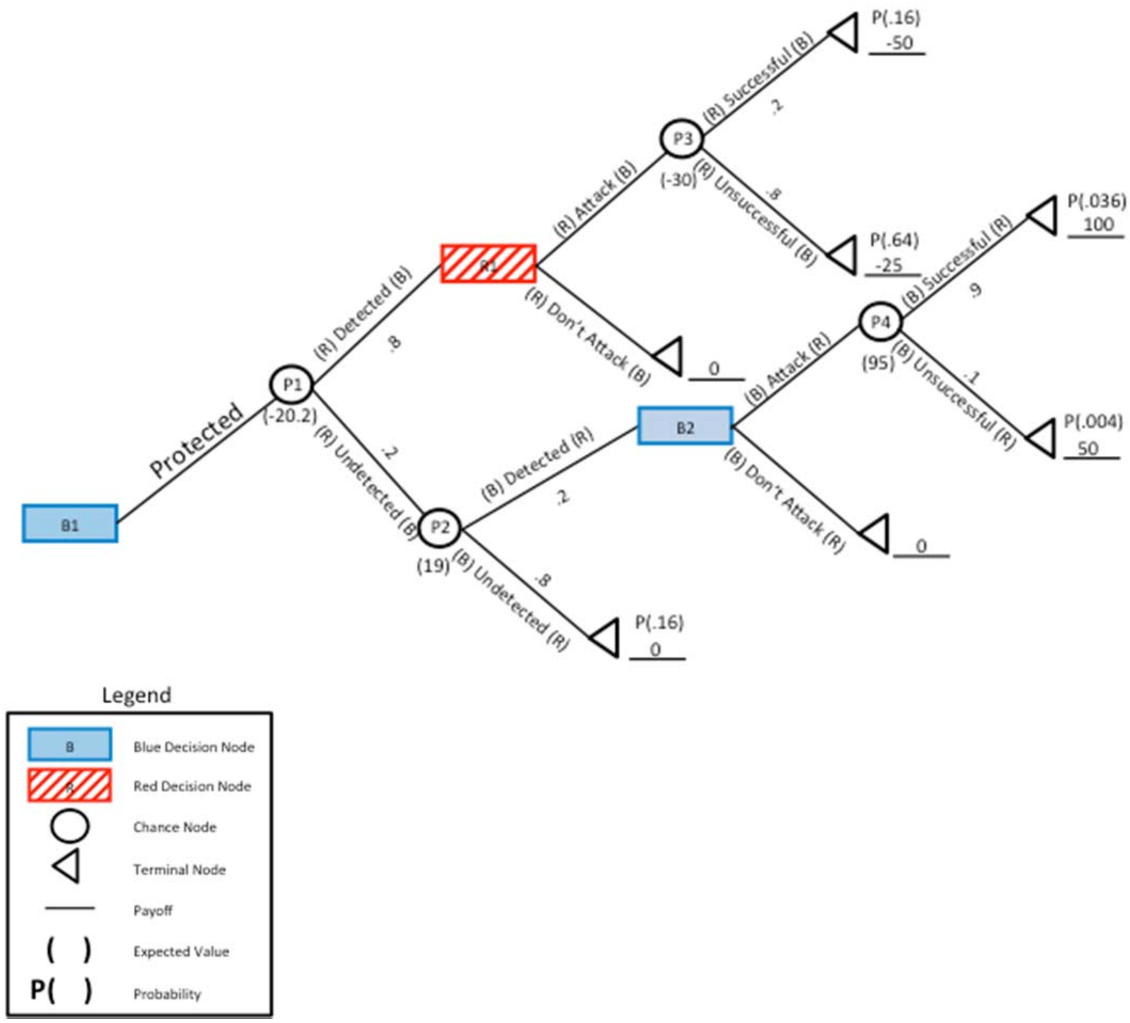

Figure 21. “Protected” Game Tree

B. “PROTECTED” GAME TREE

The “Protected” side of the game tree in Figure 21 begins with the Blue force deciding for a more survivable and lethal posture toward the enemy. The first chance node is P1 where the probability that Red will detect Blue is .8, or 80%. This probability is relatively high because of Blue’s decision to be protected. The conventional nature of the Blue force has chosen to be highly survivable and lethal yet easily detected and engaged. There still is a .2, or 20% chance that Red will not detect Blue. If Red detects Blue, which will occur four out of five times, Red will decide to attack because he wants to maximize his payoffs. In examining the P3 chance node, Red’s chance of success in

the attack comes into play. Success is only 20% because of Blue's lethality and survivability. The payoff for this series of decisions and probabilities is -50 for Blue because he was surprised by the battle from an enemy that he did not detect. Success for Red in this attack is Blue's second worst outcome because although he was attacked Blue was still highly survivable in this situation. Backing up to P3, the outcome for an "Unsuccessful Attack" by Red occurs 80% of the time with a payoff of -25 for Blue because Red is a small force with less firepower against the superior numbers of Blue. The unsuccessful attack is based on both the size of the Red force and the survivability and lethality of Blue. For Red, even when unsuccessful in the attack the force still benefits while Blue renders the cost of -25. The payoff is limited to a -25 loss because Blue is on the receiving end of an attack and he can possibly fight out of it based on his protection and lethality.

Blue's lethality plays a major role in his payoffs when Red does not detect him. Beginning again at chance node P1 there is a 20% chance that Red will not detect Blue, either due to limited visibility or carelessness of the Red force. This event is rare but still possible. This chance event is followed by another chance node P2. At P2 there are associated probabilities that Blue will or will not detect Red. There is an 80% chance that Blue will not detect Red and the two sides will not meet in conflict. This occurs often in vast areas of operation with an elusive and part-time enemy. The payoff here is zero, or the status quo where both sides gain nothing and lose nothing. More interesting is the 20% of the time that Blue detects Red. Blue will attack and have associated probabilities of success or failure at chance node P4. Based on the outlined assumptions, 90% of the time Blue will be successful in an attack. Blue has superior technology, lethality, and protection as well as external assets to exact damage on the enemy. This combination results in Blue's highest payoff of 100. The 10% chance that Blue will be unsuccessful in an attack is due to the possibility of complex terrain, weapons malfunctions, poor communication, or poor training of the unit. Even with superior technology the Red force is known to have an uncanny ability to "hinder decisive action" because of his decentralized control, speed, and ability to survive in austere environments.[45] Blue's

[45]Calwell, *Small Wars*, 124.

payoff is 50, his second highest, for even if he is unsuccessful Blue has survived and achieved some degree of decisive engagement on an elusive enemy even if only in the opening moments of the engagement upon an unaware Red force.

Using the Blue player's payoffs and probabilities associated with each outcome will determine the expected value of his decision to choose protection. The expected value of protection is -20.2. Determining this value involves multiplying each combined probability with each payoff, then summing them together. Table 5 depicts this calculation.

Protected

Terminal Node	Probability	Payoff	E(V)
1	.16	-50	-8
2	.64	-25	-16
3	.036	100	3.6
4	.004	50	0.2
5	.16	0	0
		SUM E(V) =	-20.2

Table 5. Expected Value Protected

Calculating the expected value in Table 5 is useful for analyzing this decision. It is relatively easy to see the probability of each payoff that determines the frequency of each outcome, over time. Here Red attacks Blue unsuccessfully but still achieves a benefit by initiating the attack. This will occur 64% of the time, by far the most common event. The frequency of this outcome is conceivable in this example because in a protracted conflict where a conventional force meets guerilla or insurgent forces the engagements are small, frequent, and can slowly attrit the conventional side. The relative infrequency of Blue's greatest outcome (3.6%) is also understandable based on the assumptions and the nature of insurgencies that prevent decisive engagements. Further analysis of the expected value will occur after the analysis of the Unprotected game tree.

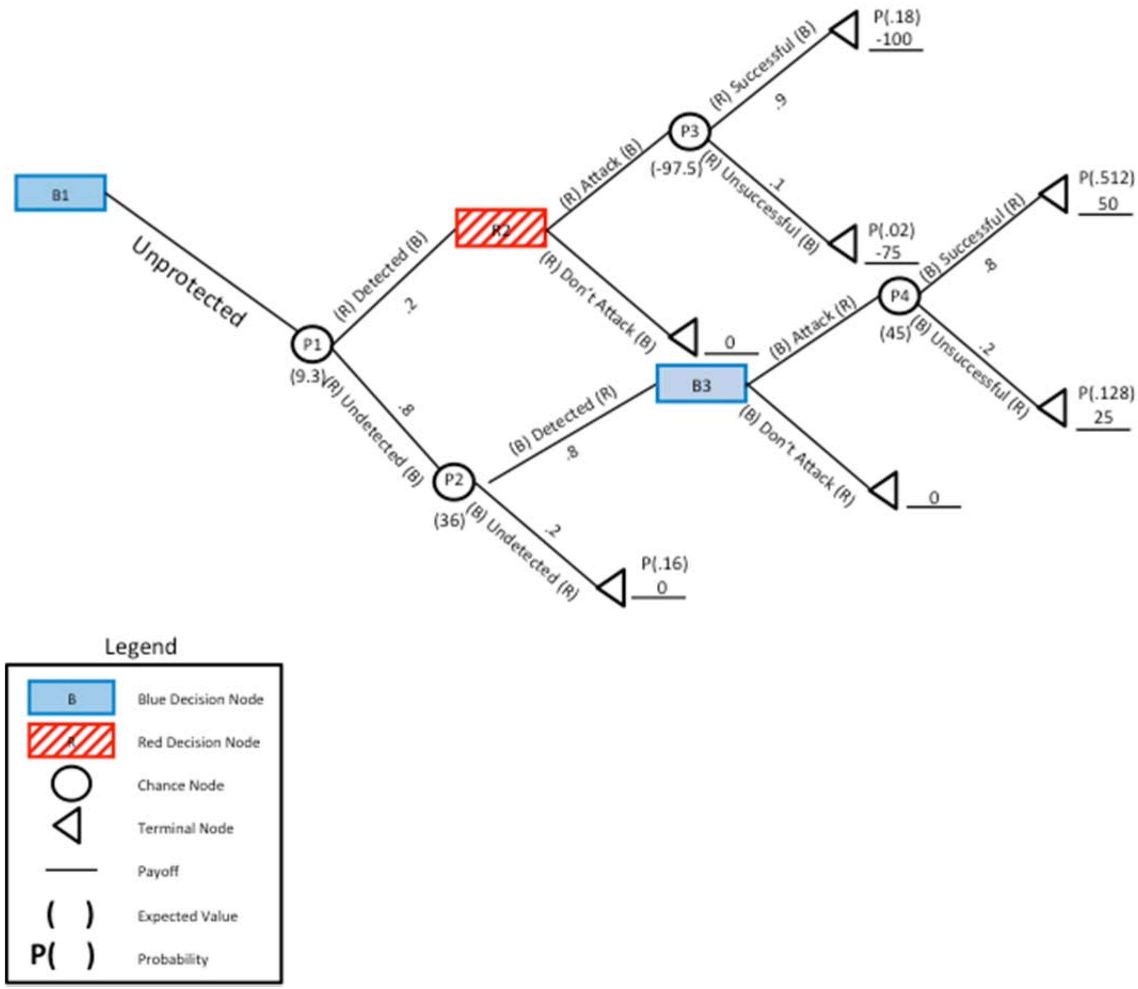

Figure 22. “Unprotected” Game Tree

C. “UNPROTECTED” GAME TREE

The “Unprotected” Game Tree in Figure 22 begins with the Blue force opting for an unprotected posture that allows the force a higher probability of being undetected by the opposition. The Blue force is placing a higher emphasis on stealth and surprise over protection and lethality. Right away the contrast to the Protected option is evident where the probability that Red will detect Blue at chance node P1 is only 20%. Upon detection, the Red force will decide to attack. When Red attacks Blue, the Blue force is less lethal and survivable, which will benefit the Red force with a high probability of success in the attack of 90%. This success will result in Red’s best payoff of 100, for they have detected

a vulnerable Blue force that has chosen to be less lethal and survivable. At chance node P3 there is a 10% probability that the Red force will have an unsuccessful attack, where the Blue force may quickly break contact or fight back with some success. This still results in the second highest payoff for Red because they have initiated an attack on a vulnerable Blue force that has less ability to fight back.

In the Unprotected option fighting back is essentially what Blue is trying to avoid. In being unprotected, Blue is attempting to avoid detection and therefore creating a situation to detect the Red force first. At chance node P1, Blue has an 80% chance of avoiding detection from Red, by far Blue's best option for setting the stage for a successful attack. Even with sacrificing protection and lethality Blue will have more frequent success in engaging Red by detecting the Red force first. Upon remaining hidden from Red, Blue now has an 80% chance of detecting Red at chance node P2. Once Red is detected, Blue will attack with success 80% of the time with his second highest payoff of 50. This success and payoff is due to the ability of Blue to initiate an attack while also being limited by less lethality than the Protected option. The other branch of chance node P4 is the probability of 20% that Blue will execute an unsuccessful attack on Red. An unsuccessful attack would involve Blue possibly engaging only a small portion of the Red force or engaging and missing the target. The payoff in this instance is still Blue's third highest. The final possible outcome of the Unprotected decision is at chance node P2 where Blue remains undetected but fails to detect Red. This payoff is zero because Blue does not lose anything but does not gain anything either.

Unprotected

Terminal Node	Probability	Payoff	E(V)
1	.18	-100	-18
2	.02	-75	-1.5
3	.512	50	25.6
4	.128	25	3.2
5	.16	0	0
		SUM E(V) =	9.3

Table 6. Expected Value Unprotected

Gaining and losing is the composition of the Blue force decisions. Just as with the Protected game tree, Table 6 helps analyze the decision for being unprotected. Here the probability of terminal node 3 is the most common outcome since in occurs just over half the time. This is important for Blue because with this option he achieves his second highest payoff over half the time. The other glaring outcome of this option is that Blue's worst payoff of -100 will occur about 18% of the time, which is almost 1 out of 5. Looking specifically at the overall expected value of the decision, choosing Unprotected gives a positive payoff of 9.3, over time.

D. DECISION CRITERIA

The payoff of 9.3 is far better than the Protected decision that results in -20.2. It seems that this decision is cut and dry where choosing protection and lethality is not as beneficial as choosing stealth to avoid detection at a lower lethality. However, the analysis must continue further to discuss decision criteria. The literature of decision-making and risk centers on the valued outcome of the decision maker. Before the decision is made one must establish what he values in the outcome of this decision. The expected value is of course a sound way to establish what outcome is the most beneficial over time. But what would be most beneficial is deceiving, which is often the explanation for a conservative strategy. Exploring the minimax of this game tree reveals that the

conservative strategy is to choose the ‘Protected’ option, for this side of the game tree guarantees avoiding the worst payoff of -100 even though Blue will incur some loss 75% of the time, no loss or gain 16% of the time, and a gain only 4% of the time.

Avoiding the worst option is a common strategy in conflict where political considerations rooted in perception often dictate the conduct of war. Michelle Malvesti, former Senior Director of Combatting Terrorism Strategy and member of the National Security Staff uses a Jimmy Connors quote to explain the minimax strategy often employed by national security advisors. Jimmy Connors said, “I hate to lose more than I love to win.” Dr. Malvesti suggests that strategies employed often focus on avoiding the worst outcome even at the expense of a higher expected value.[46] This is salient in the analysis of risk in combat because just as outlined in Chapter I in the game of Chicken, Blue may opt for a conservative strategy where he will achieve only a 2 or a 3, so he will avoid a 1 but will never achieve his best option of a 4. This idea of a conservative strategy is also important when exploring the notions of prospect theory where Blue will try to avoid his worst outcome at all costs because the value of the payoff is well beyond the limit of the utility scale.

E. RISK OF THE “PROTECTED/UNPROTECTED” DECISION

Avoiding the worst outcome and the cost of doing so involves drawing on the thorough understanding of risk outlined in previous chapters. The “Protected/Unprotected” decision is a sophisticated example that reveals the utility of understanding risk in decision-making. First, the example provides a comparison of risk where the “less risky” option does not equate to a better decision. Second, it reveals the actual cost of preventing the worst outcome. Third, it determines what the true cost of the worst outcome would be on an extended utility scale in order to make the expected value of each decision equal. This in turn reveals how important the worst outcome is to the decision maker. Fourth, the game tree can be analyzed on different levels of detail to include the probability of loss and the probability of benefit. Analyzing on different

[46] Dr. Michelle Malvesti, lecture, Naval Postgraduate School, September 2012. http://jackson.yale.edu/malvesti.

levels helps reveal the fourth utility of the analysis that the decision process illuminates the important variables, meaning the variables that most affect the outcome of the decision. This will focus the decision maker to affect the right variable instead of influencing all variables, where the latter tends to be ineffective.

Protected

Terminal Node	Probability	Payoff	E(V)
1	.16	-50	-8
2	.64	-25	-16
3	.036	100	3.6
4	.004	50	0.2
5	.16	0	0

SUM E(V) = -20.2

MINIMAX (Worst Outcome) = -50

MAXIMAX (Best Outcome) = 100

Unprotected

Terminal Node	Probability	Payoff	E(V)
1	.18	-100	-18
2	.02	-75	-1.5
3	.512	50	25.6
4	.128	25	3.2
5	.16	0	0

SUM E(V) = 9.3

MINIMAX (Worst Outcome) = -100

MAXIMAX (Best Outcome) = 50

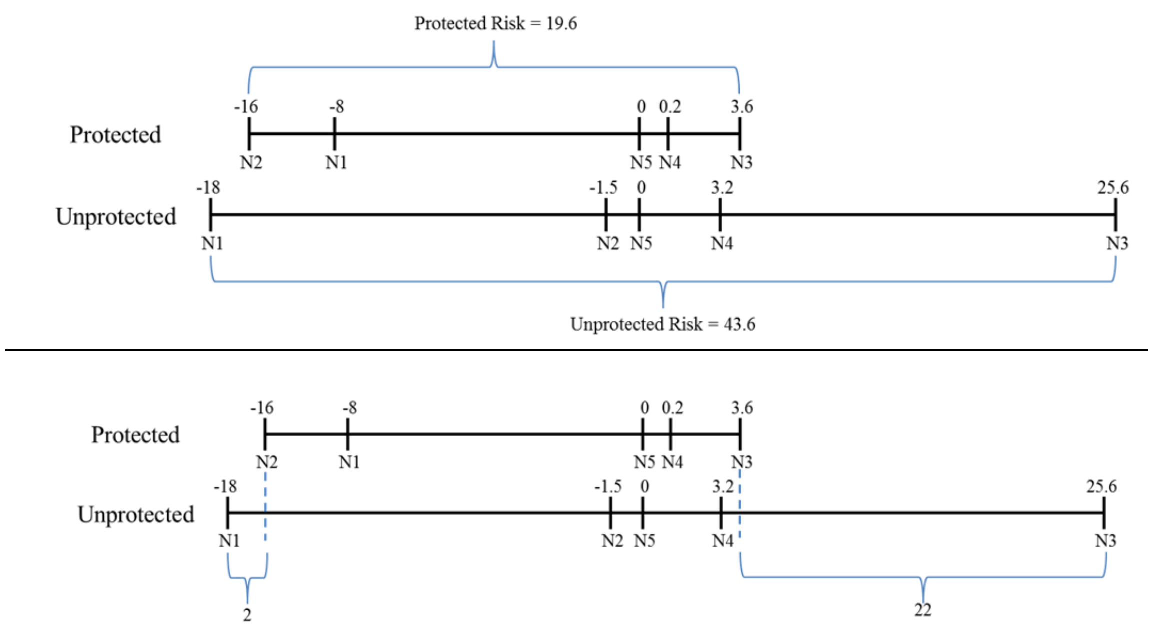

Figure 23. “Protected” and “Unprotected” Risk

Figure 23 contains both expected value tables for the Protected and Unprotected decision. Each table contains the possible outcomes of each decision with the associated probability and payoff for each outcome. Below the tables is a linear depiction of the dispersion of the expected values that displays the variance of the outcomes, or risk, for each decision. The linear graphic of each decision displays an easy way to compare one to the other. First, the Protected decision is less risky than the Unprotected decision. Less risky means there is less variance in the outcomes. For Protected, the dispersion from -16 to 3.6 is 19.6 where the Unprotected option has dispersion from -18 to 25.6 for a total of 43.6, making Unprotected more than twice the risk of Protected. Second, the Protected table shows that the worst outcome with a -100 payoff is not possible therefore choosing Protected avoids the worst outcome. There is a cost associated with making this choice. The tradeoff of cost and benefit is easily seen in the linear graphic where avoiding the cost of 2 (-16 to -18 the worst expected value of each decision) at the missed benefit of 22 (25.6 to 3.6 the best expected value of each decision). The cost-benefit ratio is 1:11, where one mark of cost is worth eleven marks of benefit for the Protected choice. Another way to look at the differences of the two choices is that for both expected values to equal -20.2, the worst outcome would have to be worth -272 instead of -100. If the Protected option was chosen to avoid the worst outcome then -272 is what that value is actually worth to that decision maker.

Focusing on the tables will scale the analysis into simpler components. Combining probabilities will determine the probability of cost and benefit for each option. When combining the probabilities of terminal nodes three and four of the Protected decision, the outcomes with a positive payoff occur .04 or 4% (.036 + .004) of the time. This decision has a 4% chance of resulting in a benefit. Doing the same for the Protected decision results in 64% (.512+.128=.64) probability of benefit. Conducting the same analysis for probability of cost the Protected and Unprotected choice has 80% and 20% probabilities, respectively. If the decision criteria or strategy is to maximize benefit this analysis shows that choosing “Unprotected” is the right choice. Equally as beneficial is analyzing the value of avoiding the worst outcome. The choice for the minimax

strategy is "Protected," and the analysis shows how much that avoidance is really worth, which will aid in determining if that is the right strategy.

The analysis of cost and benefit also reveal that not all the variables affect the expected value of the decision with the same weight. Looking again at the game tree in Figure 20 *detection* is the variable that determines cost or benefit. Once the probability node P1 determines the route in the game tree, the ability for one side to detect the other determines the payoff, while the other variables (probability of success or degree of protection) determine to what *degree and frequency* that payoff is attained. This statement provides an interesting comparison of the focus of each decision. The Protected decision has more focus on controlling the variables that determine the *degree* of payoff while almost conceding the detection variable to the enemy. Conceding detection is clear through the frequency of cost and infrequency of benefit. The Unprotected decision is the opposite where the focus is on avoiding detection while detecting the opposing force thus increasing the probability of benefit, reducing the probability of cost, and also enabling the possibility, although infrequent, of the worst payoff.

F. PRACTICAL APPLICATION

Presenting realistic examples of the abstract principles in The Game Tree in Figure 20 will further illustrate the reasoning for the probabilities and payoffs, the decision making process of identifying variables and how they affect outcomes, and why leaders make certain decisions and possibly why those decisions may not be the best.

1. Up-Armored HMMWV vs. Pick-up Truck

The first example of the "Protected" or "Unprotected" choice is moving through a combat zone protected in an Up-Armored HMMWV (UAH) or relatively unprotected in a civilian pick-up truck. The UAH is protected and easily identifiable by the enemy. If the enemy chooses to attack upon detecting a UAH then the vehicle proves its worth because it is highly survivable and provides a legitimate fighting platform with a machine gun. The pick-up truck is a common civilian vehicle to the combat zone and is widely used by civilians. The enemy would have difficulty detecting opposing forces in this vehicle. If detection occurred then surviving an attack from this vehicle would be difficult because it

is not armored and shooting effectively from this platform would require getting out of the vehicle with small caliber weapons.

Two common decision errors stem from this example. The first issue is ingrained in the current culture of the military where policy prevents the flexibility to even make a choice. The leadership of the military under the pressure of the current political culture seeks to avoid loss and bolster positive perceptions. The perception of moving in less protection and lethality in a combat zone even with the slim possibility of detection is for the most part intolerable. The pressure of perception forces leaders to opt for the minimax strategy that seeks to avoid the worst outcome even at more cost in the long run. The second error is that the lack of choice characteristic of centrally controlled militaries is rarely questioned, which maintains a rock-solid status quo, the foundation of which is virtually immovable.

2. Body Armor vs. No Body Armor

The same status quo is evident in the debate over body armor. This example has slightly different variables but the same decision process that poses a choice between protection of body armor or foregoing that protection for increased mobility by not wearing it. This is similar to the abstract example in this chapter because there is a focus on affecting the variables that have less effect on the outcome. Body armor is designed to protect the vital organs but is so heavy that it significantly reduces the mobility of the soldier making him easily targeted. Bluntly stated a soldier protects his chest but is so slow he exposes his head. Additionally, the weight of the armor makes a shooter less effective due to becoming easily tired. The decision for body armor clearly is focused on avoiding being killed or making injuries less lethal at the cost of increased lethality and maneuver against enemy forces.

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Figure 24. Cuirass Body Armor Hit by Cannon Ball, Battle of Waterloo, 1815

Figure 24 is a striking example of the body armor decision and risk in general. The intent of the cuirass, an older form of body armor, in the French military was for protection. This protection gave up mobility and the cannonball-sized hole through the front and out the back obviously displays the limits of the desired protection. In terms of risk the brass chest piece illustrates that while a low probability, the worst outcome is always looming.

3. Occupying Nuristan vs. Avoiding Nuristan

A slightly different example with different variables deals with operational level warfare decisions. This centrally revolves around the structure, meaning the terrain and

[47] Musee de l'Armee, National Military Museum, Paris, France, accessed November 14, 2012, http://www.ageod-forum.com/attachment.php?attachmentid=2987&stc=1&d=1213451770.

population density, of the operational environment and the strategy, meaning the plan to accomplish the mission, employed to win in that environment. The obvious shortfall resides in operational decisions that choose areas with difficult structures, namely mountains and jungles, then pair the difficult structure of the environment with poor strategy, namely a focus on amounting enemy casualties instead of positively manipulating the will of the people. Obviously a difficult structure and a poor strategy results in the worst outcome, where a manageable structure and sound strategy result in the best outcome. An example of this poor decision is the province of Nuristan, Afghanistan. This area is mostly rugged mountainous terrain containing a diverse population. Historically there has been little connection of this area to anyone outside of it, much less a centrally controlled government. There is little strategic interest in this region. Occupying the area is a decision with high costs and low benefits. A plausible reason that occupying this area would occur is due to a focus on the wrong variable. Here structure will often determine if the perfect strategy would even work. Thus, the structure is the illuminating variable that affects whether the outcome will yield a cost or a benefit. The strategy is an additional variable that determines the degree of the cost or benefit.

4. Protect the Force vs. Accomplishing the Mission

The final example is intended to pose a problem that deserves additional analysis and argue that the decision process outlined in this chapter is a good place to start. There exists a perpetual balance surrounding command decisions with protecting the force and accomplishing the mission. In conventional conflict these two ideas complement one another where one side protects the force through accomplishment of the mission. More plainly stated to protect your force you kill the other force. In the complexity of irregular warfare these two ideas work in opposite directions. The difficulty is that protecting your own force by killing the other force does not accomplish the mission and in most cases it degrades mission accomplishment. The center of this problem resides in a sound calculation of risk and determining the variables and the values of the cost and benefit. Edward Luttwak in his "Notes on Low-Intensity Warfare" provides insight that a relational-maneuver force, a term he uses for an adaptable force that configures based on

the operational environment, "offers high payoffs of low material cost in exchange for corresponding risks."[48] A deeper understanding of risk will help decision-makers realize that any hopes of accomplishing the mission in irregular conflict will require an increased acceptance of risk in terms of protecting the force and in doing so will aid in accomplishing the mission.

G. CONCLUSION

Understanding and managing risk in combat requires a decision process. This process should help reveal variables that influence the outcomes of the decision as well as *how* each variable influences the outcomes. The 'Protected/Unprotected' example reveals that the detection variable alone determined if the outcome would yield a cost or a benefit while the other variables determined the degree of cost or benefit in the outcome. This determination then aids the decision maker to determine *whether* he can influence the variable and then *how* he can influence each variable. Central to this decision process is to understand risk in order to determine the decision criteria. The two strategies proposed were expected value and minimax. Expected value focuses decisions on maximizing value while minimax focuses decisions on avoiding the worst outcome. Oftentimes, the value of the worst outcome extends well beyond the limits of the utility scale, but determining the actual value of that outcome will further enhance the knowledge applied to a decision. The example also displayed how the option with the lowest risk does not always make it the best decision, which reinforces conclusions of previous chapters that proposed the riskiness of risk aversion. Ultimately, the decision process aids decision-makers in identifying the components of a decision, which components are subjective and which components are objective, how those components affect the decision, and acknowledgement of the array of possible outcomes.

[48] Edward N. Luttwak, "Notes on Low-Intensity Warfare," *Parameters* (Carlise, PA: U.S. Army War College, 1983), 14.

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V. CONCLUDING REMARKS

A quick look at the extensive literature about risk reveals its sub-categories including risk perception and risk communication and is a testament to the vastness of the topic. Despite the ever-presence of risk in decisions, two people will rarely assess the risk of a decision in the same way. The intent of this work has been to increase the knowledge of risk to military decision makers who due to the nature of their decisions should be experts. This work was limited to defining risk and illustrating its dynamics in military environments and utilized various methods.

Throughout this work it is prudent to conclude with three main points. First, the use of mathematical principles, economics, decision theory, and game theory is enormously useful in understanding risk. This methodology utilizes theoretical scenarios to objectively define risk. Alternative less rigorous methods make risk elusive and mysterious, largely conditional, and loosely defined. The methodology of this work depended deeply on the objective results to illuminate the subjective aspects of risk. In this way, two individuals with different understandings of the subject can now speak the same risk-language and constructively debate the subjective aspects that involve assigning probability.

Second, risk aversion is very risky. This idea is vital for military leaders to understand. Currently, most people try not to be risk averse because they just think they are not supposed to be. This work has utilized economic principles to show that risk aversion leads to unpreparedness. The economic principles helped tightly tie the training and combat environment together while still respecting their differences.

Third, the dynamics of risk all point to the importance of a decision process that includes determining the decision criteria, recognizing of the array of possible outcomes of the decision, and identifying of the variables that affect the outcomes. It is paramount in managing risk in irregular conflict to have “a small influence over the right variables than a large influence over variables that are less likely to shape the outcome of the

conflict."[49] Balance throughout the decision process will prevent cognitive bias rooted in emotions that are often the genesis of poor decisions throughout history. Many are guilty of thinking Pearl Harbor, an assault through the Ardennes Forest, and 9/11 were all impossibilities. Ultimately, the outcome of a decision is never certain, but a sound decision process that includes decision criteria will reveal the best decision based on the knowledge available.

[49] Gordon McCormick et al., "Things Fall Apart: The Endgame Dynamics of Internal Wars," *Third World Quarterly*, 28, no. 2 (2007): 364.

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